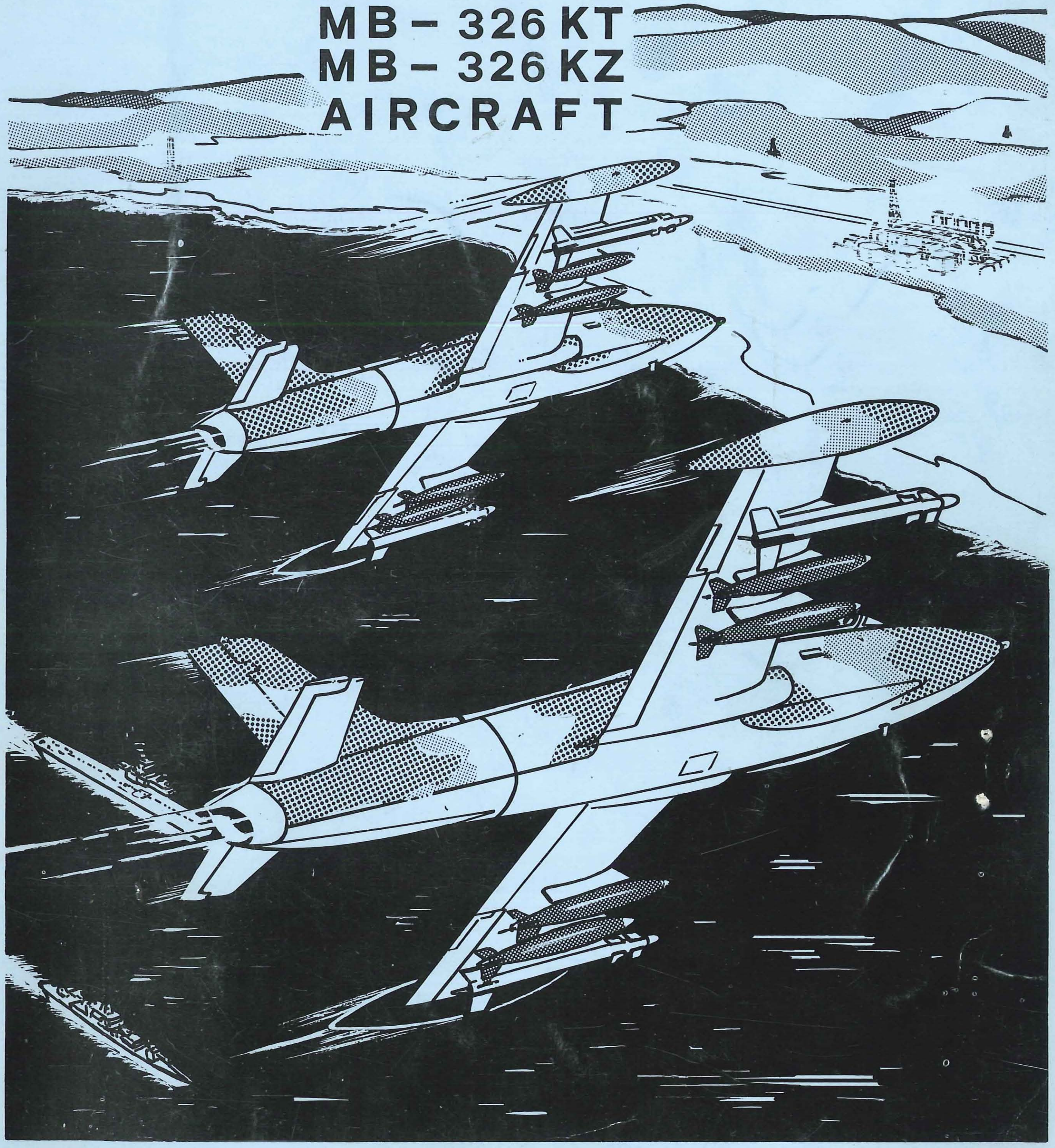
AIRCREW WEAPON DELIVERY MANUAL

BASIC INFORMATION

AERMACCHI MB-326KD
MB-326KC
MB-326KB
MB-326KT
MB-326KZ
AIRCRAFT



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Technical Publications Department

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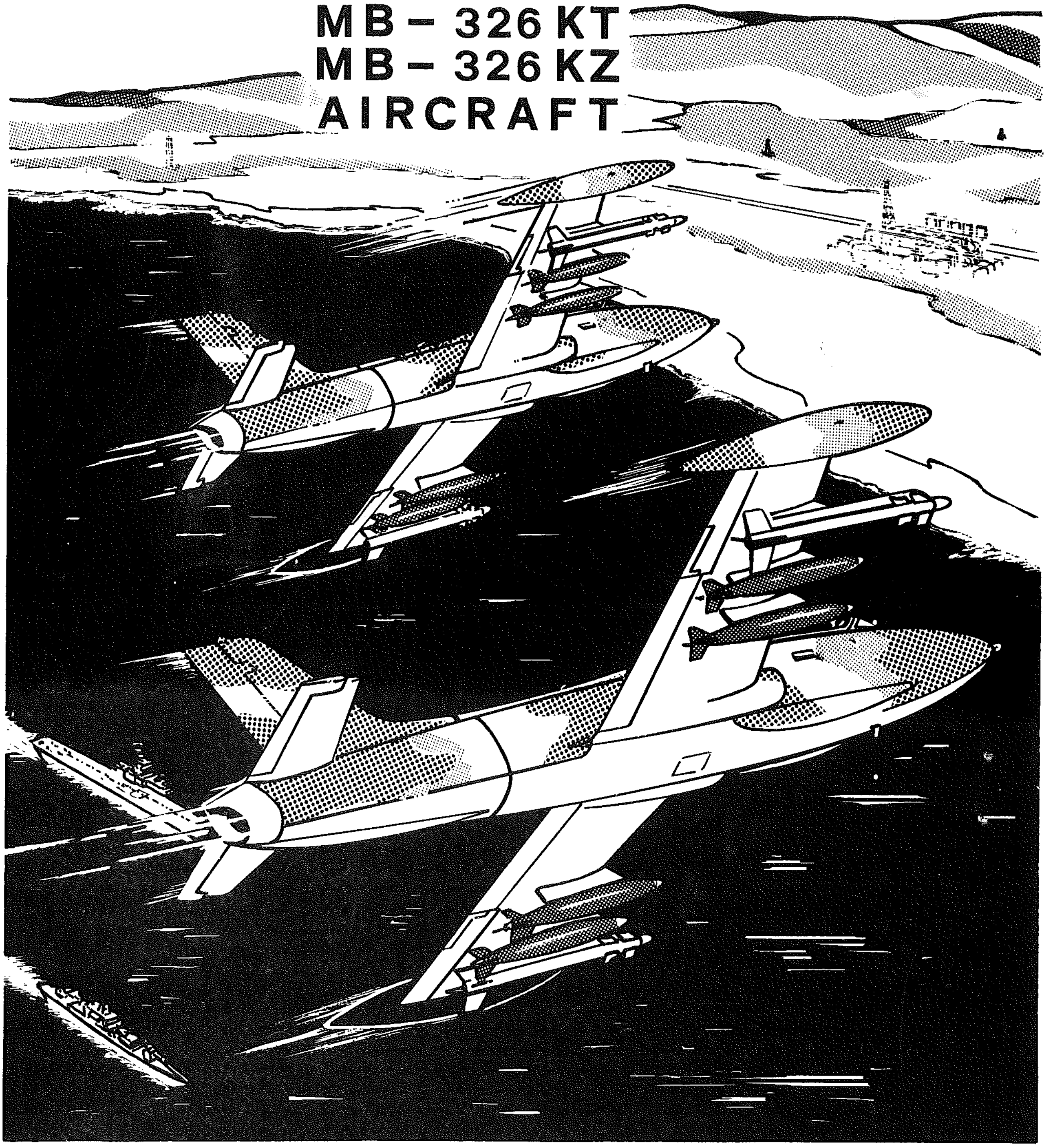

THIS PUBBLICATION IS INCOMPLETE WITHOUT MANUAL P.I. 1A-MB326KD-34-1-2
"AIRCRAEW WEAPON DELIVERY MANUAL - BALLISTIC TABLES"

AERMACCHI - VARESE (Italia)
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20 JANUARY 1981

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FOREWORD

PURPOSE AND SCOPE

This Aircrew Weapons Delivery Manual provides tactical pilots with the information required to perform all types of missions employing combat or training weapons.
Weapon delivery techniques or tactics are not included, except in a general view, to describe a practice range procedure or a particular delivery maneuver or to support certain ballistic data. When a conflict exists between Flight Manual and this technical manual, the flight manual will take precedence. This manual contains the data required to plan a combat attack or a practice mission, using the MB-326K( ) aircraft with the munitions listed in the table "Munitions and Associated Equipment" of this Foreword.

ASSOCIATED WEAPON DELIVERY MANUAL

Weapon release tables are contained in Volume 2: P.I. 1A-MB326KD-34-1-2 "Aircrew Weapon Delivery Manual - Ballistic Tables". The volume is divided into four Sections as follows:

Section I	Bomb Ballistic Tables
Section II	Flare Release Tables
Section III	Rocket Ballistic Tables
Section IV	Gun Ballistic Tables

EXTERNAL STORES LIMITATIONS

Limitations related to carrying, releasing, and jettisoning externally carried munitions or drop tanks are presented in "Flight Manual".
Limitations are presented in table form with illustrations showing specifically how a given store shall be loaded on the aircraft. Included in the table are airspeed and g limitations for each store loading. Stores listed in the table are the only stores approved for carriage on the aircraft.

ARRANGEMENT

SECTION I, DESCRIPTION

Section I is divided into seven parts and contains a description of the munitions delivery modes, associated aircraft munitions systems and controls, munition suspension systems, munitions (combat), munitions fuzes, and training munitions and equipment.

SECTION II, NORMAL AIRCREW PROCEDURES

Section II contains the amplified instructions for the performance of combat or training missions, including procedures necessary to insure correct loading and configuration of all munitions, in-flight delivery procedures, after landing procedures for unexpended munitions and munition jettison procedures.

SECTION III, EMERGENCY AIRCREW PROCEDURES

Section III contains amplified procedures for emergency release, malfunction procedures and fire fighting and evacuation criteria.

SECTION IV, SUPPLEMENTARY DATA

Section IV contains a wide variety of miscellaneous subjects, including safe separation data, error analysis and conversion charts, recording and assessing practice weapons delivery, range specifications and procedures, and the optical sight check.

SECTION V, PLANNING PROCEDURES AND SAMPLE PROBLEMS

Section V describes the planning charts and ballistic tables and presents a sample problem to illustrate mission planning procedures.

SECTION VI, PLANNING CHARTS AND TABLES

Section VI contains the safe escape charts, conversion tables, planning forms and safe recovery tables necessary for planning a combat attack or practice mission.
Ballistic tables are contained in Volume 2 (P.I. 1A-MB326KD-34-1-2).

HOW TO BE ASSURED OF HAVING LATEST DATA

Refer to the "Supplement Status" page, which is included in the manual along with each supplement for checking the current status of the manual. This status page provides the list of the active supplements and also the basic publication date and the date of the latest change to P.I. 1A-MB326KD--34-1-2.

SAFETY SUPPLEMENTS

Information involving safety will be supplied to you by "Safety Supplements". The title page of the manual and the title block of each Safety Supplement should be checked to determine the effect they may have on existing supplements. You must remain constantly aware of the status of all supplements.

OPERATIONAL SUPPLEMENTS

Information involving changes to operating procedures will be supplied to you by "Operational Supplements". The procedure for handling "Operational Supplements" is the same as for "Safety Supplements". Operational Supplements are issued as an expeditions means of reflecting information when a deficiency in the publication may result in a reduction of the aircraft operational capability, although safety of flight is not affected.

NUMBERING OF SUPPLEMENTS

Safety and operational supplements to the manual will be numbered consecutively regardless of the type of supplement issued. For example, the first supplement issued will be numbered SS-1 or S-1 dependent upon whether it is safety or operational and the second supplement issued will be numbered -2 regardless of whether it is safety or operational.

CHANGE SYMBOL

The change symbol, consisting of a black vertical line indicates text and tabular illustration changes made to the current issue. Changes to illustrations (except tabular and plotted illustrations) are indicated by a changed area box located at the upper right side of the illustration. The box is divided into eight equal parts which represent eight proportional areas of the illustration. The shaded area of the box represents the area of the illustration which contains a change. An unshaded box indicates no change. The word "NEW" will appear in the box for new illustrations.

WARNINGS, CAUTIONS AND NOTES

The following definitions apply to warnings, cautions and notes found throughout the manual.

WARNING	An operating procedure, practice, etc. which, if not correctly followed, could result in personal injury or loss of life.
CAUTION	An operating procedure, practice, etc. which, if not strictly observed, could result in damage to, or destructions of equipment.
NOTE	An operating procedure, condition etc, which it is essential to highlight.

PUBLICATION DATE

The date appearing on the title page of this manual represents the currency of material in the manual. (The publication date is not the printing or distribution date). When referring to the manual, use the publication date plus the date of the latest change.

COMMENTS AND RECOMMENDED CHANGES

Every effort is made to keep this manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. For the manual to be usefully amended, comments, corrections and change proposals from all users are however invited.
These should be forwarded on Form 22 "Publication Defect Report".

AIRCRAFT DESIGNATION CODES

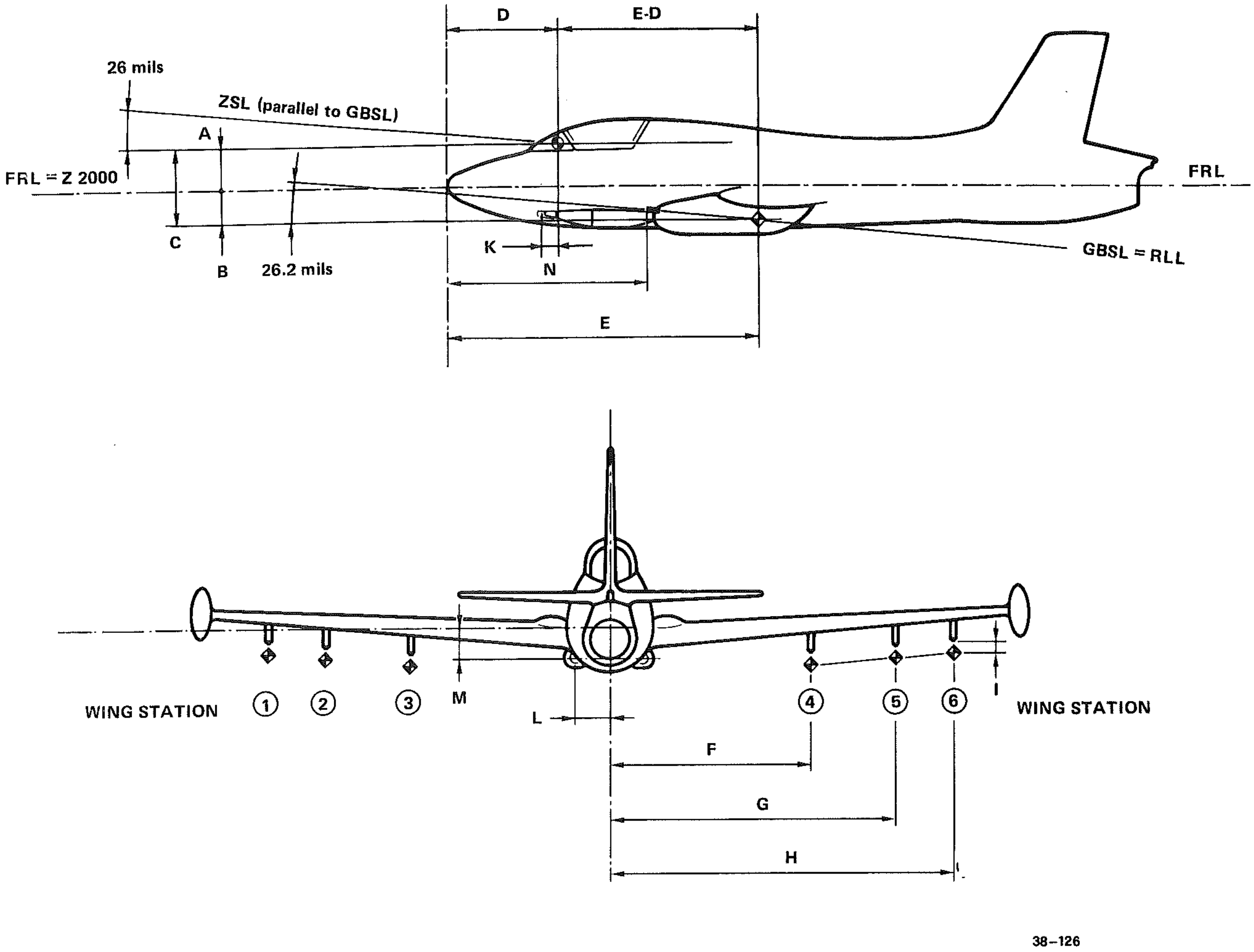
Changes to the aircraft which affect procedures are indicated by a coding system. The coding system assigns symbols which represent the manufacturer type of aircraft. For example, symbols which read [A], [B] after MB-A-0148 mean "aircraft MB-326KC and MB-326KD after modification by MB-A-0148".
Codes are as follows:

[A]	MB-326KC
[B]	MB-326KD
[C]	MB-326KT and MB-326KZ
[D]	MB-326KB

MUNITIONS AND ASSOCIATED EQUIPMENT

This manual covers the following munitions and associated equipment. Attention is however drawn to the fact that the stores qualified for operational use in the aircraft within the limitations set forth in the applicable Flight Manual, are only the stores whose MIN (Macchi Identification Number) is marked by an asterisk.
For details refer to Macchi Publication P.I. 11-1-1 "Armament Data Sheets".

	MACCHI IDENTIFICATION NUMBER (MIN)
CANNONS (INTERNAL)	
DEFA Type 553, caliber 30 mm cannon	
PYLONS AND PODS	
MACCHI GB900-20-11 and GB900-20-36, Underwing Pylons	0-11B81-001*
MACCHI M910-21-10 and M910-22-10, Machine Gun Pods	11W1-003*
MACCHI 11B29-003, Bomb/-/flare Dispenser	11B29-003*
SUU-11( )/A, Mingun Pod	11W1-001*
MACCHI 39A940-31/32, 30 mm Gun Pod	11W1-009*
BOMBS	
AN-M30A1, GP Bomb, 100 lb	11A1-007*
AN-M57A1, GP Bomb, 250 lb	11A1-009*
AN-M64A1, GP Bomb, 500 lb	11A1-010*
SAMP 57, GP Bomb, 260 lb	11A1-008
SAMP 25, GP Bomb, 550 lb	11A1-006*
SAMP 25A, GP High Drag Bomb, 550 lb	11A1-019*
MATRA Type 50 kg, GP Bomb, 130 lb	11A1-005*
AN-M81, Fragmentation Bomb, 250 lb	11A1-020
MATRA 81, Fragmentation Bomb, 250 lb	11A1-004
AN-M88, Fragmentation Bomb, 220 lb	11A1-004
AEREA 559G1, Fire Bomb, 500 lb	11A2-001*
MK81, Low Drag GP Bomb, 250 lb	11A1-011*
MK82, Low Drag GP Bomb, 500 lb	11A1-025*
PRACTICE BOMBS	
AN-M38A2, Practice Bomb, 100 lb	11A1-027*
MK86, Practice Bomb, 250 lb	11A1-014
MK76, Practice Bomb, 25 lb	11A1-013*
BDU-33/B, Practice Bomb, 25 lb	11A1-013
BDU-33( )/B, Practice Bomb, 25 lb	11A1-028
BDU-33/B, Practice Bomb, 25 lb	
FLARES	
LUU-1B, Flares, 36 x 5 in., Marker	11A10-001
LUU-2B, Flares, 36 x 5 in.	11A10-003*
MK24, Flares, 36 x 5 in.	11A10-002
ROCKET LAUNCHERS	
MATRA F2, Rocket Launcher, 6 x 68 mm	11L1-014*
MATRA 155M, Rocket Launcher, 18 x 68 mm	11L1-009*
AEREA LR-25-0 and AL-25-50, Rocket Launchers, 25 x 50 mm	11L1-007*
AEREA AL-18-50, Rocket Launcher, 18 x 50 mm	11L1-021



DIMENSIONS

A	Aeritalia 8.105.924 gunsight	639 mm
	Thomson-CSF RD21 gunsight	684 mm
	Thomson R322Z(M) gunsight	684 mm
B	12.7 mm machine gun pods or minigun pods on pylons 3 and 4	331 mm
	Bombs or rockets on pylons 3 and 4 (mean position)	555 mm
	Bombs or rockets on pylons 2 and 5 (mean position)	495 mm
	Bombs or rockets on pylons 1 and 6 (mean position)	460 mm
C	= (A + B) = Z parallax distance (armament to gunsight)	
D	Aeritalia 8.105.924 gunsight	1594 mm
	Thomson-CSF RD21 gunsight	1565 mm
	Thomson R322Z(M) gunsight	1565 mm
E	12.7 mm machine gund pods or minigun pods on pylons 3 and 4	4163 mm
	Bombs or rockets on pylons 3 and 4 (mean position)	4740 mm
	Bombs or rockets on pylons 2 and 5 (mean position)	4908 mm
	Bombs or rockets on pylons 1 and 6 (mean position)	5058 mm
F	Pylon stations 3 and 4	2691 mm
G	Pylon stations 2 and 5	3541 mm
H	Pylon stations 1 and 6	4290 mm
I	Mean position of bomb and rocket center of gravity below hook points and halfway between the two rack hooks	165 mm
K	Gunsight to DEFA gun muzzle X parallax:	
	Aeritalia 8.105.924 gunsight	–3 mm
	Thomson-CSF RD21 and Thomson R322Z(M) gunsights	26 mm
L	Gunsight to DEFA gun Y parallax	412 mm
M	DEFA gun Z parallax	442 mm
N	Aircraft nose to cal. 0.50 in. gun muzzle	3405 mm
	The guns when harmonized to converge fire at 1000 ft slant range distance, should converge toward aircraft plane of symmetry:	
	– from pylon stations 3 and 4	9 mils
	– from pylon stations 2 and 5	11.6 mils
	– from pylon stations 1 and 6	14.1 mils

Figure 1. Aircraft Armament System Geometric Data

	MACCHI IDENTIFICATION NUMBER (MIN)
LAU-32B/A, Rocket Launcher, 7 x 2.75 in.	11L1-005*
LAU-39G, Rocket Launcher, 7 x 2.75 in.	11L1-015*
LAU-68A, Rocket Launcher, 7 x 2.75 in.	11L1-025*
LAU-10A, Rocket Launcher, 4 x 5 in.	11L1-024*

ROCKETS

FFAR, 2.75 in. Rocket	11A11-001*
SNEB F1, 68 mm Rocket	11A11-004*
SNIA ARF/8M2, 50 mm Rocket	11A11-005*
ZUNI, 5 in. Rocket	11A11-006*

CANNON AND MACHINE GUN AMMUNITIONS

30 mm Ammunitions
12.7 mm (Caliber .50 in.) Ammunitions
7.62 mm (Caliber .30 in.) Ammunitions

The guns, when harmonized to coverage fire at 1000 ft slant range distance, should coverage toward a/c plane of symmetry:

From Pylon Station 3 and 4 = 9 mils

From Pylon Station 2 and 5 = 11.6 mils

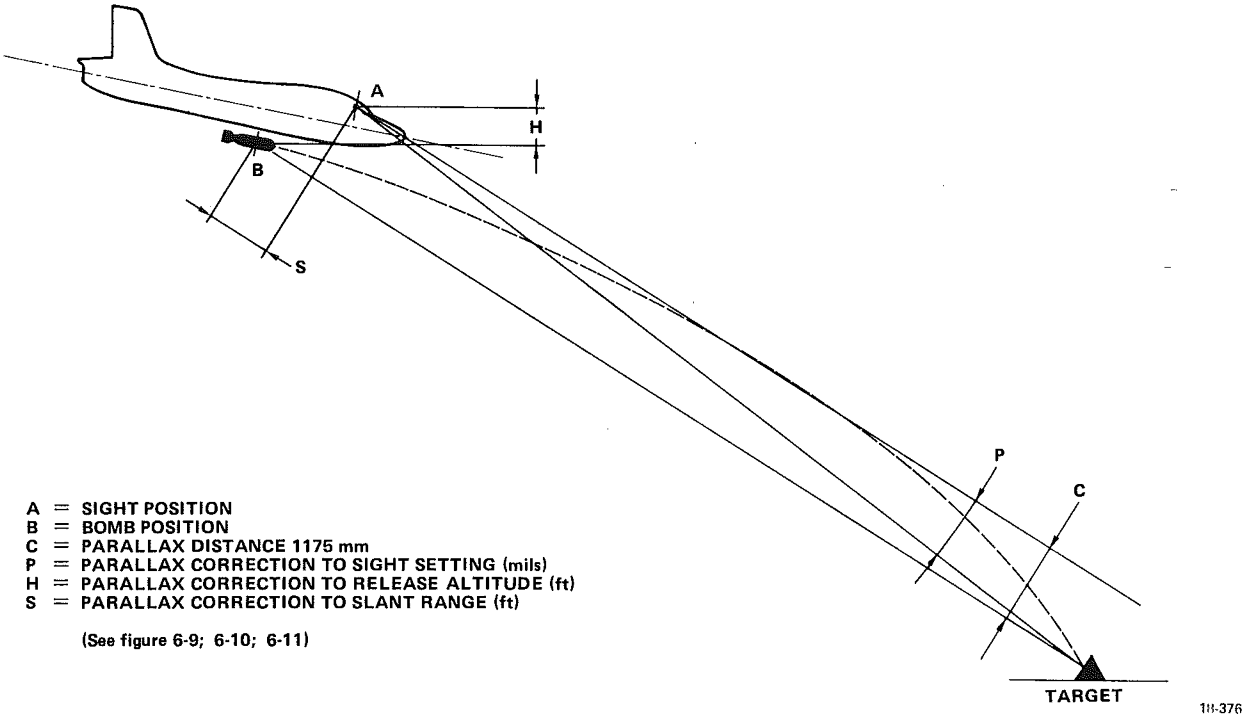
From Pylon Station 1 and 6 = 14.1 mils

PARALLAX CORRECTION

Parallax correction for all gunsight, in mils, has been calculated upon means position A of gunsight assumed to be 680 mm and mean position B of Bombs and Rockets assumed to be 495 mm (see fig. 2).
Therefore C = A + B = 680 + 495 = 1175 mm

Figure 6-11 in Section VI is calculated, for bombs only, (parallax correction versus slant-range) upon the above Parallax distance of 1175 mm. For gyro gunsight: correction already made for a mean slant range of 2250 ft.

The firing tables in Volume 2 concerning the Sight settings calculated for machine-



A = SIGHT POSITION
B = BOMB POSITION
C = PARALLAX DISTANCE 1175 mm
P = PARALLAX CORRECTION TO SIGHT SETTING (mils)
H = PARALLAX CORRECTION TO RELEASE ALTITUDE (ft)
S = PARALLAX CORRECTION TO SLANT RANGE (ft)

(See figure 6-9; 6-10; 6-11)

Figure 2. Parallax Correction

guns and rocket fire, are considering, together with the various corrections, also the parallax correction and the windshield refraction correction.

AIRCRAFT ARMAMENT DATA LINES (See fig. 3)

A. Lines

FRL	Fuselage Reference Line (Z = 2000)
FP	Flight Path
GBSL	Gun Bore Sight Line, coincident with RLL
EGBSL	Effective Gun Bore Sight Line
RLL	Rocket Launcher Line
ZSL	Zero Sight Line
SDL	Sight Depression Line

B. Angles

A Fuselage Reference Line Angle of Attack (Flight Path to FRL). See Table of fig. 6-3.

B Gun Bore Sight Line to FRL, 26 mils above FRL

B Zero Sight Line, parallel to GBSL

C Zero Sight Line, 26 mils above FRL

D ZSL Angle of Attack (26 mils ± A)

E Sight Depression Angle from Flight Path. See Ballistic Tables (See Volume 2)

F Sight Depression Angle from ZSL (D + E)

G Velocity jum angle: always measured from (GBSL toward FP.

VELOCITY JUMP (See fig. 4)

Va.	Aircraft velocity (feet/sec) True Airspeed
Vm.	Muzzle velocity (feet/sec), also Rocket Initial Velocity
EGBSL.	Effective Gun Bore Sight Line, also Effective Rocket L.L.

$$\text{Velocity Jump (mils)} = E = \alpha'' \frac{Va}{Va + Vm}$$

a. Guns

The velocity jump correction at the speeds, the dive angles, and the aircraft mass at

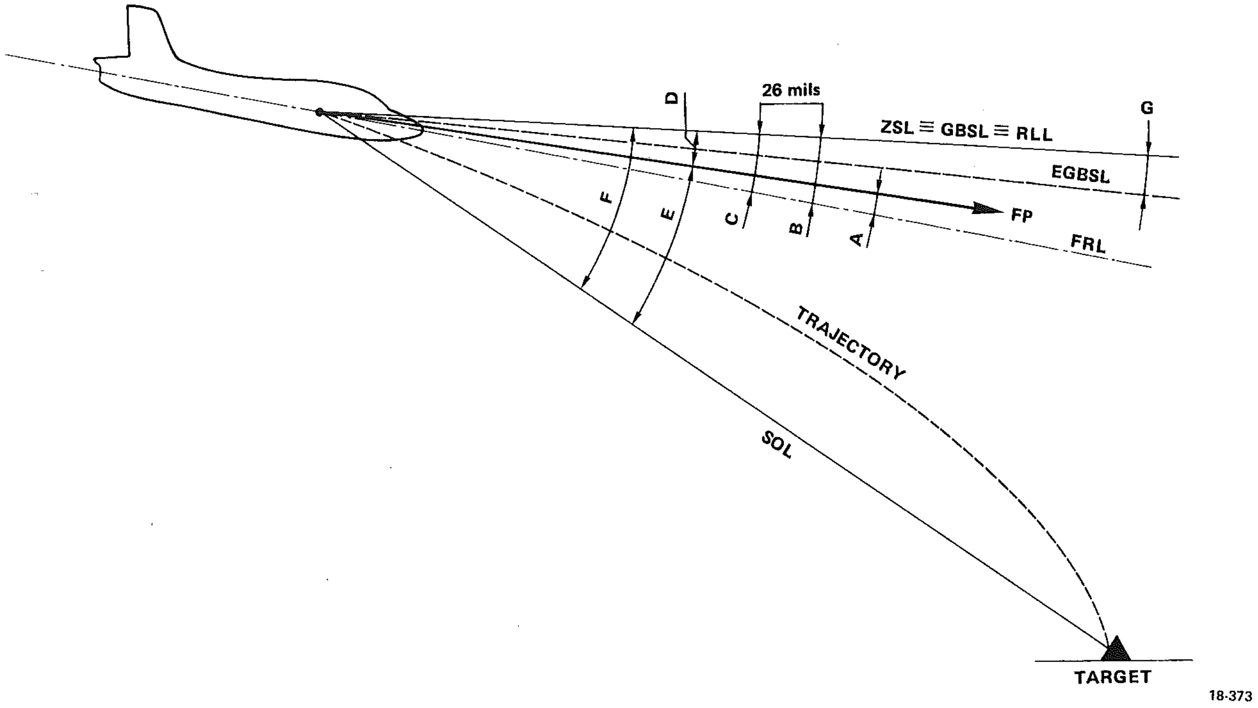


Figure 3. Aircraft Armament Data Lines

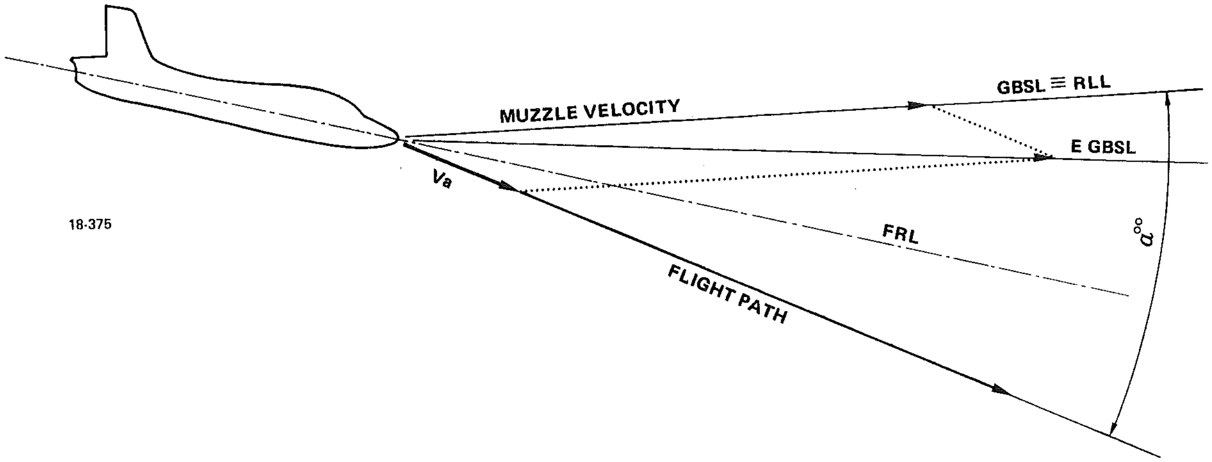


Figure 4. Velocity Jump

which the aircraft is normally operated is very small, as demonstrated by table of figure 6-13. Firing tables, nevertheless compute the Vj correction.

b. Rockets

The rockets velocity jump (RLL is inclined upward of 26.2 mils respect to FRL) is calculated in function of the rocket initial velocity and the correction is considered as "F FACTOR" in table of figure 6-16.
Firing tables compute the rocket Vj correction.

TRAJECTORY SHIFT

a. Rockets

The rocket launchers can be installed under any of the six underwing stations. The RLL's are parallel between them and parallel to the aircraft plane of symmetry. Consequently does not exist lateral trajectory shift for the rockets provided the firing is performed without crabbing the aircraft. During rocket firing, as for bomb release, the pilot must consider that the underwing stations are laterally displaced from the sight line.
If the bombs or the rockets are to be released singly, allowance must be made for the lateral distance (see figure 5) between the bomb rack, or the rocket launcher, and the aircraft centerline.

b. Machine Guns

The machine-gun pods Aermacchi M910-21-10 and M910-22-10 for AN-M3 Cal .50 guns can be installed only on No. 3 and 4 underwing stations. The minigun pods can be installed on any underwing station.

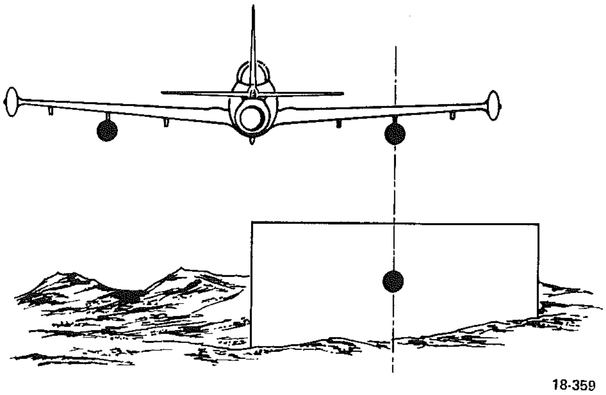


Figure 5. Compensation for Wing Rocket Launcher

The gun harmonization is carried out to concentrate the fire on the impact point 1000 ft from the gun muzzle. The trajectory shift (see figure 6), has the consequence to displace, in function of TAS, the fire impact point beyond the 1000 ft.
For: Va = 350 kt = 590 ft/s ; Vm = 2700 ft/s.

For the guns installed on the underwing stations 3 and 4 the trajectory shift will be as follows:

$$\text{Trajectory Shift E} = \alpha^{\cdot\cdot} \text{ x } \frac{Va}{Va + Vm} \text{ x } \frac{2691}{304{,}000} \text{ x }$$

$$\text{x } \frac{590}{590 + 2700} = 8.57 \text{ x } 0.179 = 1.54 \text{ mils}$$

EGBSL angle = 8.57 - 1.54 = 7.03 mils

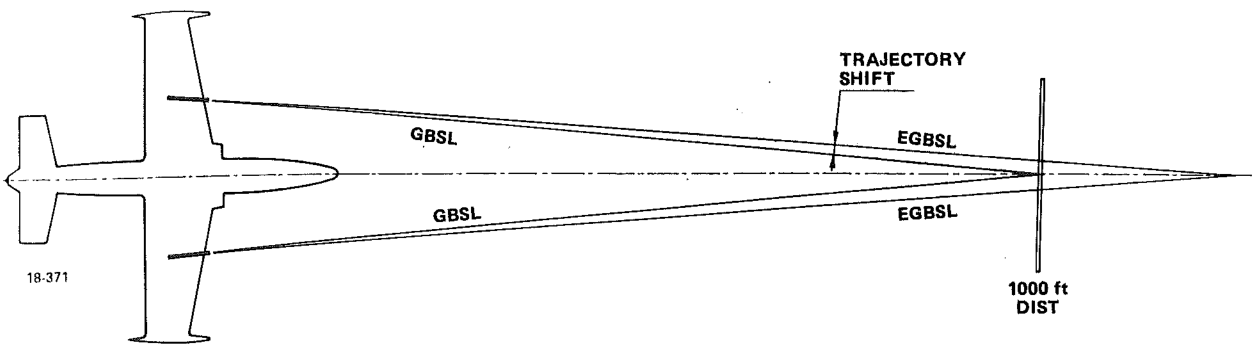


Figure 6. Trajectory Shift

which corresponds to an effective convergency distance of:

$$\frac{2691}{7.03} = 383 \text{ m} = 1260 \text{ ft}$$

Following the above mentioned process, the effective convergency distance for stations 1 and 6 will be 1130 ft.

c. Cannons

The 30 mm DEFA internal cannons are installed slightly divergent (2.5 mils) but the forces acting during firing cause the projectiles to follow parallel tracks at 804 mm distance. Therefore there is no lateral trajectory shift.
The 30 mm DEFA gun pods Aermacchi 39A940-31/32 can be installed only on No. 3 and No. 4 underwing stations.

The cannon harmonization is carried out to concentrate the fire on the impact point 2000 ft from the gun muzzle. The trajecotry shift (see figure 7) has the consequence to displace, in function of TAS, the fire impact point beyond the 2000 ft.
For average Va = 350 kt = 590 ft/s ; Vm = = 2700 ft/s.

$$\text{Trajectory Shift} = \alpha'' \text{ x } \frac{Va}{Va + Vm} \text{ x } \frac{2691}{609,6} \text{ x}$$

$$\text{x } \frac{590}{590 + 2700} = 4,4144 \text{ x } 0.179 = 0.792 \text{ mils}$$

EGBSL angle = 4,4144 - 0.792 = 3.623 mils

which corresponds to an effective convergency distance of:

$$\frac{2691}{3.633} = 742.75 \text{ m} = 2443 \text{ ft}$$

SECTION I

DESCRIPTION

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PART 1 - MISSION DESCRIPTION

GROUND ATTACK - GUNS

The gun attack (figure 1-1) against surface targets, commonly known as strafing, is the most versatile and accurate method of delivering ordnance against a target, and therefore, is highly effective against a wide variety of targets that are vulnerable to cal 30 mm, 12.7 mm and/or 7.62 mm ammunition.

On the MB-326K( ) aircraft can be installed up to six minigun pods SUU-11B/A.

Normally only two miniguns cause a 68% bullet burst concentration at the distance of 1000 ft inside a circle of 3.35 ft diameter, equivalent to 68 bullets on the target in a 0.5 s. Consequently it is not necessary to install more than two miniguns to the prejudice of other ordnance stores.

To increase the operational flexibility of the armament system the minigun pods can be installed on any of the six pylons, but it is suggested, when possibile, to install them at the underwing stations No. 3 and 4. The Aermacchi machine gun pod Ref. No. M910-21-10 can only be installed under the wing at station 3 and the machine gun pod Ref. No. M910-22-10 at station 4 only. The strafing attack is easily performed and may be initiated with a minimum of preplanning. The attack may be initiated from an angle-off or straight-head approach. The dive angle may be varied to fit the particular target situation. The lower dive angles (5 to 15 degrees) are generally more effective, due to ease in tracking. The main concern during this delivery, is firing at the proper slant ranges, where bullet impact is in proximity to the pipper position. If firing is to be accomplished beyond these ranges, the sight is depressed so that the pipper position and bullet impact will coincide. Another method of correcting for this condition is to hold the pipper above the target the proper amount so that bullet impact is on the target. Tables are presented in Volume 2 to provide the correction necessary under various delivery conditions. Although the effect is small, both range-wind and crosswind do affect the strafing attack and must be compensated for, especially on pinpoint targets.

GROUND ATTACK - ROCKET DELIVERY

Rocket delivery (figure 1-2) considerations are essentially the same as dive bombing,

GROUND ATTACK - GUNS

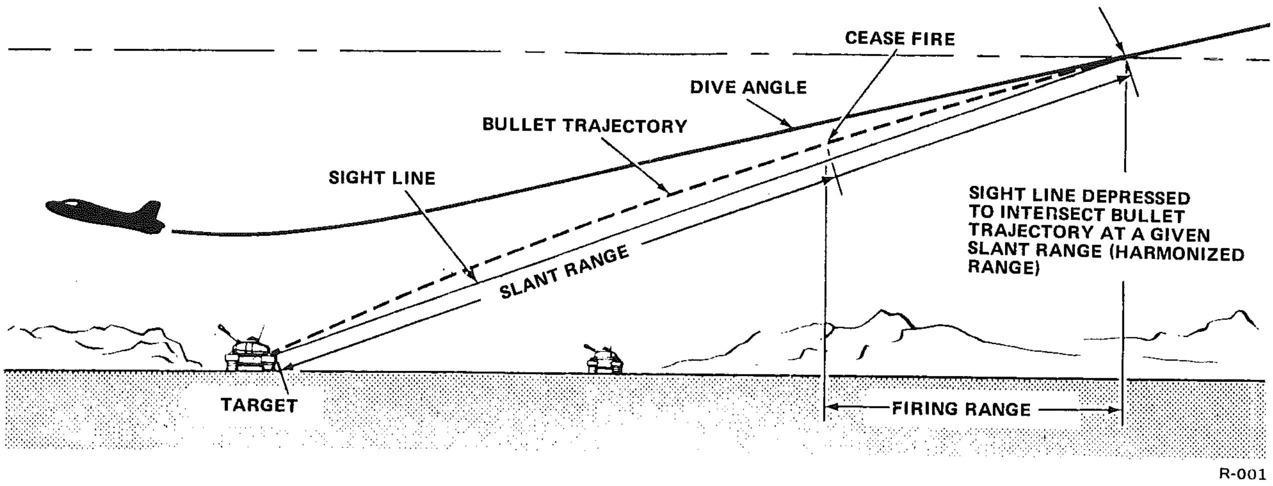

OPEN FIRE
CEASE FIRE
DIVE ANGLE
BULLET TRAJECTORY
SIGHT LINE
SLANT RANGE
SIGHT LINE DEPRESSED TO INTERSECT BULLET TRAJECTORY AT A GIVEN SLANT RANGE (HARMONIZED RANGE)
TARGET
FIRING RANGE
R-001

Figure 1-1.

GROUND ATTACK - ROCKET DELIVERY

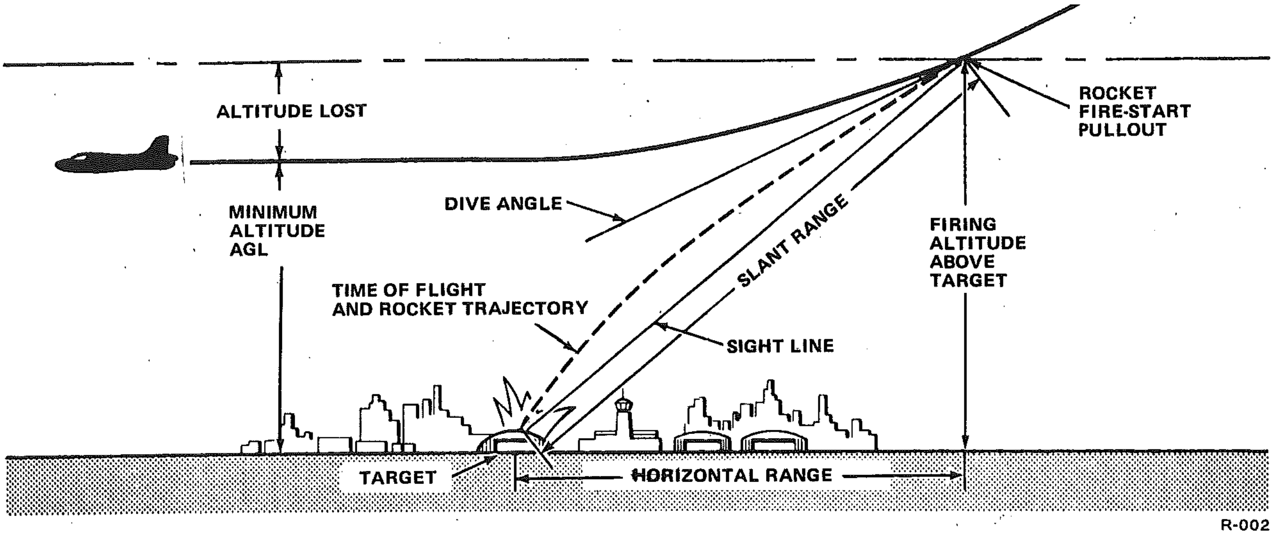


Figure 1-2.

with respect to roll-in position, wind correction, release point, and pull-out maneuver.

To the Aermacchi pylons, installed on the six underwing stations, can be hooked the rocket launchers and the adapters that permit the use of almost any type of air rockets.

The rocket launcher tables in Volume 2 provide sight settings for no-wind conditions as a function of aircraft gross mass for various launch conditions. All that remains to be accomplished is to determine the necessary rangewind and crosswind corrections.

DIVE BOMB DELIVERY

Dive bombing (figure 1-3) is usually divided into the following three categories: high-angle, medium-angle, and low-angle. The dive bombing tables in Volume 2 provide trajectory data for dive angles from 15 through 55 degrees for general purpose bomb deliveries. Consistency in the all important roll-in parameter cannot be over-emphasized. The parameters of altitude, airspeed, distance from target, and power setting must be designed to place the aircraft at a predetermined release altitude and distance from target, with a predetermined bomb release velocity, in order to effect an accurate impact. Because of the longer periods of wind effect on the trajectory of the bomb, it is also important that the pilot have knowledge of the magnitude of wind effect and, primarily, the wind velocity at release altitude.

The optical sight is used, in conjunction with the altimeter, to determine the release point. The bombing tables provide the sight depression angle relative to the fight path. To obtain the actual sight setting:

add the zero sight line angle of attack obtained from the angle of attack chart;

add parallax correction corresponding to slant range;

add the windshield refraction correction angle.

Several factors must be considered when determining an indicated release altitude: altitude loss during pullout, minimum aircraft ground clearance, altimeter lag, fragment envelope clearance, fuze arming time, altimeter position error and target elevation. The altimeter is set according to target pressure reduced to sea level. Immediately following bomb release, a 3 or 4-g pullot is initiated. The acceleration rate of 3 or 4-g is normally attained in 2-seconds after bomb release.

FIRE BOMB DELIVERY

Release of fire bombs may be accomplished by two modes of delivery, depending upon target characteristics and terrain features. The two delivery methods are: low-level bombing and low-angle bombing.

DIVE BOMB DELIVERY

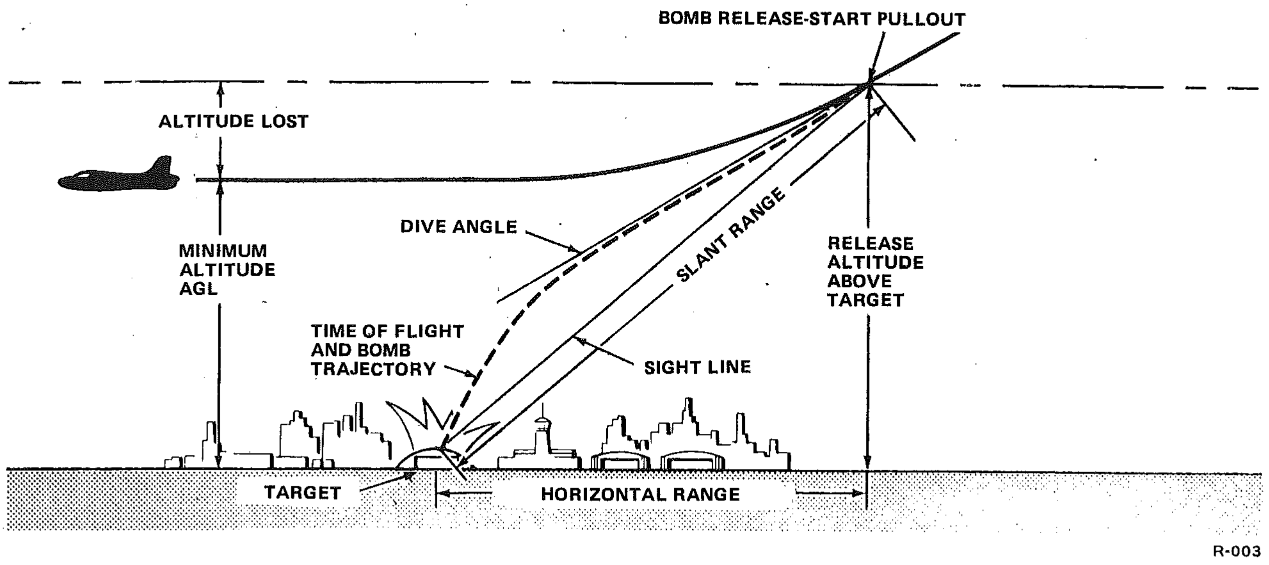


Figure 1-3.

LOW-LEVEL BOMBING (figure 1-4)

This consists of a low-altitude level approach to the aimpoint and maintenance of a predetermined release airspeed and altitude. Ballistic tables are furnished for altitudes of 50 through 2000 ft above target elevation. During low-level bombing, release airspeed and maintenance of height above the target are established during level flight approach to the target. The optical sight aiming used to determine the release point for low-drag weapons is accomplished by crabbing into the wind so that the aircraft flight path is directly over the target. An additional offset aimpoint correction may be required for location of bombs in relation to aircraft centerline when delivering high-drag weapons, due to the increased time of flight and high wind acceptance va-

LOW ANGLE BOMBING - FIRE BOMB

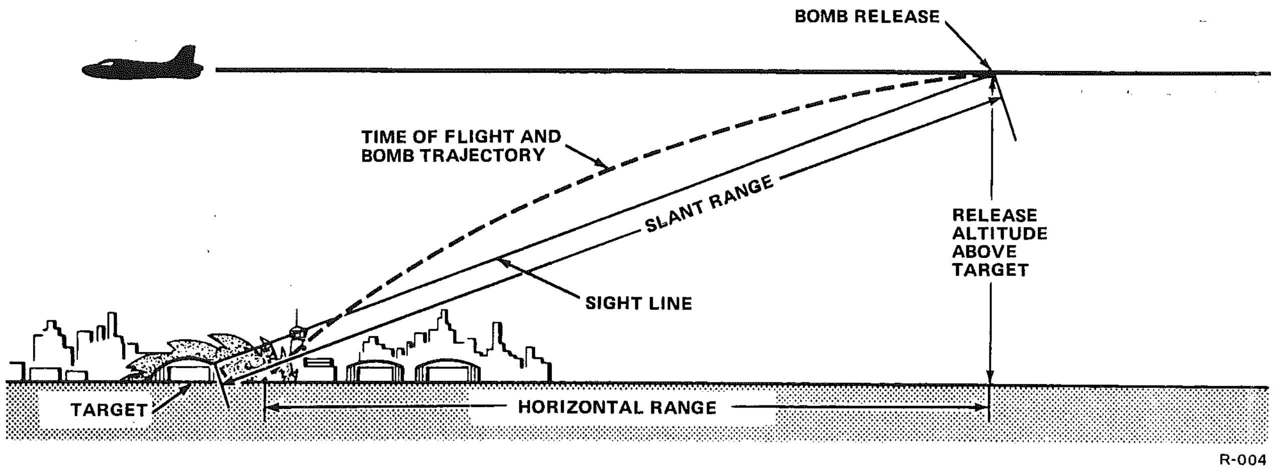

BOMB RELEASE
TIME OF FLIGHT AND BOMB TRAJECTORY
SLANT RANGE
RELEASE ALTITUDE ABOVE TARGET
SIGHT LINE
TARGET
HORIZONTAL RANGE
R-004

Figure 1-4.

lues. Crabbing to eliminate crosswind may cause the sighting reference to be offset from the target at release. The considerations in delivering fire bombs during a low level bomb attack are essentially the same as in dive bombing. The aircraft must be flown to attain a position at a predetermined release altitude, slant range from the target, and release velocity in order to have an accurate bomb impact. A depressed sight line, corrected for rangewind is used as a reference. Correction for crosswind, during this delivery, requires an offset aim-point due to the aircraft drift at release affecting the bomb line of flight.

LOW-ANGLE BOMBING (figure 1-5)

This consists of a shallow-dive angle approach to the aimpoint and maintaining a predetermined release airspeed and dive angle. Ballistics tables are furnished for altitudes from 150 to 6000 ft above target elevation and at dive angles from 5 through 45 degrees.
Level bombing and dive bombing tables are provided with dive angles from zero to 55 degrees. The sight depression angle given in the table is computed to place the fire bomb on target, when it is desirable for the fire bomb to hit short of the target, the distance must be estimated or the sight setting computed using the Sight Depression Charts, Section VI. Wind correction can be applied in the same manner as for the low drag bombs. Refer to wind corrections, Section VI. The dive recovery charts must be used to determine the minimum release altitude.

WARNING

- Do not fly over or near burst area within 20 seconds of detonation of live bombs as aircraft damage can result from flying debris. During training missions, at least 20 s spacing between aircraft must be observed when inert or sand filled bombs are released. In the training situation, observing the 20 s spacing between aircraft prevents a bomb-to--aircraft collision in the event a bomb releases low drag and ricochets into the air after impact.
- DO NOT FLY through FIRE BOMB SMOKE within 20 s of burst as a compressor stall or flameout could occur.
- Practice bomb ballistics tables in Volume 2 are provided for BDU-33/B, BDU-33A/B, and BDU-33B/B bombs, covering the same delivery parameters listed for actual weapon delivery.

LOW LEVEL BOMBING - FIRE BOMB

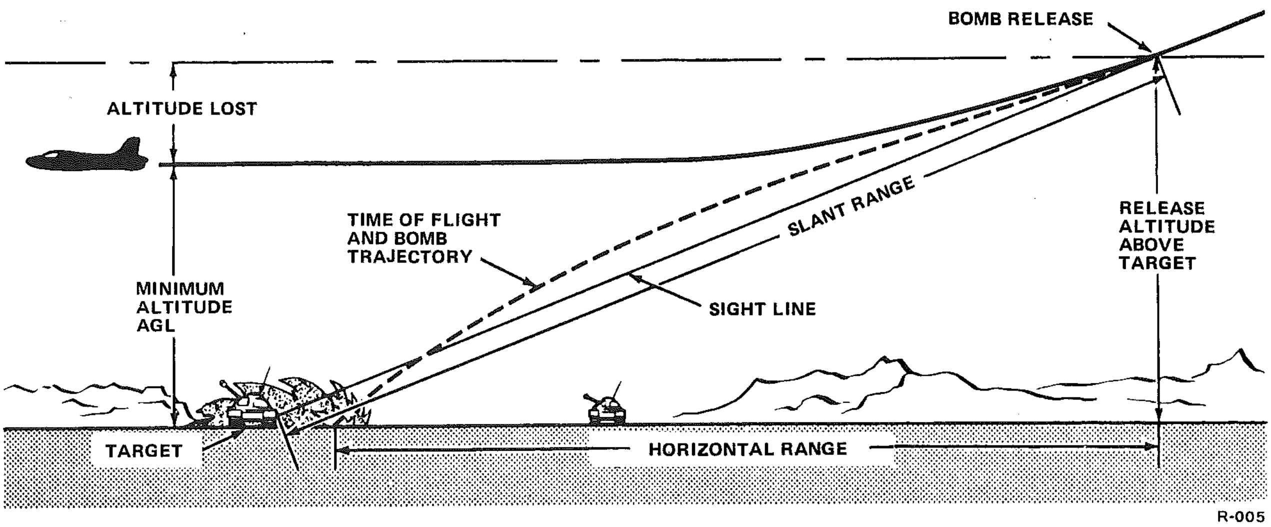


Figure 1-5.

AERIAL ATTACK - GUNS

The pilot of MB-326K( ) aircraft can successfully perform aerial attacks with the 30 mm DEFA internal cannons and the caliber .50 machine-guns by using the gyro sight Thomson Type RD21 or Thomson R322Z(M). By using fixed sights, like the Aeritalia 8-105-000, is hardly probable to perform a "pure pursuit curve" and the only way to obtain acceptable results is to engage the target in trail posizion with angles lower than 20° and to enforce the same fire technique that is used against moving targets on the ground placing the pipper ahead of target's line of motion.

In aerial gunnery the angle by which the gun line must be offset from the line of sight for the bullets to collide with the target at a predicted point is called "prediction angle". The illustration (fig. 1-6) shows that in fighter gunnery the prediction angle is compounded of lead, gravity drop correction and velocity jump correction.

When the gun is fired the bullet takes off along a path diverging from the gun line by the amount of the velocity jump. Thence forward the bullet drops because of the pull of gravity so that it falls to the path of the target and collides with it when the target reaches the predicted point of collision. It is possible for the fighter pilot to make a skillful guess as to the magnitude and direction of the prediction angle when speeds are low and ranges are short. But if longer-range requirements are added to those of high speed, accurate hitting demands computing devices that will remove all or most of pilot estimation.

With gyro computing sights the reticle is positioned by the gyro-computer system to the proper lead angle necessary for bullet impact on the target. However, the target must be tracked smootly for a minimum of one second for proper lead information to be transferred to the gunsight.

Proper operation and interpretation of the gyroscopic sight system is necessary for successful completion of the aerial "lead pursuit" attack along such a path that the

AERIAL ATTACK - GUN

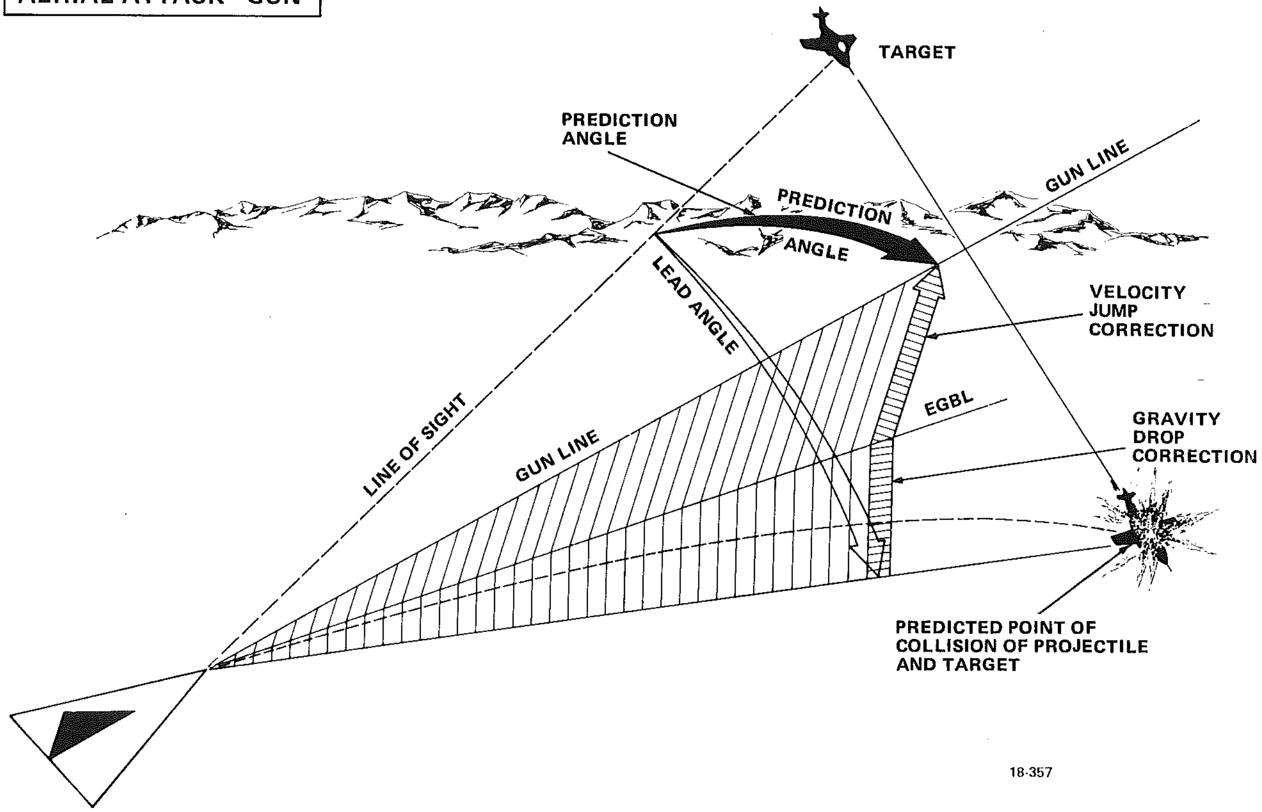


Figure 1-6.

pilot may fire the guns at any time the pipper is on the target, and, if within range of the guns, expect the bullet to hit the target.

Nevertheless, considering that both the gyro sights that can be installed on MB-326K( ) aircraft are not provided of range computer, air density unit, and g sensor, but they can only correct the gravity drop and the velocity jump only for one range, altitude, and acceleration; the fire accuracy is only obtained if the attack is performed as close as possible to the pre-set conditions.

Although the error is small the aerial attack corrections tables presented in Section VI indicate the corrections to be applied, shifting the "pipper" from the target center, while carrying out attacks in non-standard conditions.

PART 2 - AIRCRAFT MUNITIONS SYSTEM AND CONTROLS

WEAPON SYSTEMS - GENERAL

The MB-326K( ) aircraft are equipped to carry bombs, rockets, dispensers, guns. Controls are provided in the aircraft for firing the guns, rockets and for the release of bombs. All armament controls described in this manual are located in the cockpit of the aircraft unless otherwise specified. A gun camera is provided in the aircraft to record results of weapon expenditure.

ARMAMENT JETTISON

The emergency button, labelled "EXT STORES JETTISON" is located on the left side of the instrument panel. Pressing the button causes the immediate, simultaneous "safe" release of all external loads carried under the pylons.
The pylons will remain attached to the aircraft.
The button receives power from "essential 28 V dc bus bar" and is protected by a circuit breaker on circuit breaker panel, located on the cockpit-right side console. A jettison manoeuver is possible only when either the landing gear strut is in the extended position or the "GROUND FIRE" switch is held in the ON position. If the underwing stores are bombs they are always dropped in a safe condition since the supply of power to "FUSE" switch is cut off by depressing the EXT STORES JETTISON.

ARMAMENT CIRCUIT BREAKERS

A circuit breaker is designed to protect the operating units within a particular electrical circuit from overloads or short circuits, and is capable of automatically breaking the circuit under specified conditions of current flow.
The practice of using circuit breakers as switches should be avoided. Circuit breakers should not be pulled in flight, as this could cause complete system malfunction. Also, there is always the danger of pulling the wrong circuit breaker, causing failure of another system. Resetting circuit breakers can be entirely safe, provided circuit breaker operation and the individual circuit involved are thoroughly understood.
The armament circuit breakers are located in the cockpit right side console.
The armament circuit breakers are connected to the electric power bus bars as follows:

a. 28 VDC ESSENTIAL BUS
   - STORES JETT (15 A)

b. 28 VDC PRIMARY BUS
   - SIGHT & GUN CAMERA (7 1/2 A)

c. 115 VAC PRIMARY BUS
   - SIGHT

d. 28 VDC SECONDARY BUS
   - ARMT MSTR (5 A)

e. 28 VDC ARMAMENT AND SECONDARY BUS
   - ARMT SEL (5 A)
   - ARMT (15 A)
   - R BSTR MOTOR (20 A)
   - L BSTR MOTOR (20 A)
   - L WING GUN HTR (15 A)
   - R WING GUN HTR (15 A)

ARMAMENT CONTROLS

Store release and or firing predispositions are carried out from the armament control panel in the cockpit. Fire of the forward-firing armament (guns and rockets) is controlled by the trigger on the control stick, store release is controlled by a thumb-operated push-button still on the control stick.
An emergency external store release control, powered from the essential loads dc bus, is provided in the cockpit.
The armament controls are described and illustrated in figure 1-7.

ARMAMENT CONTROLS

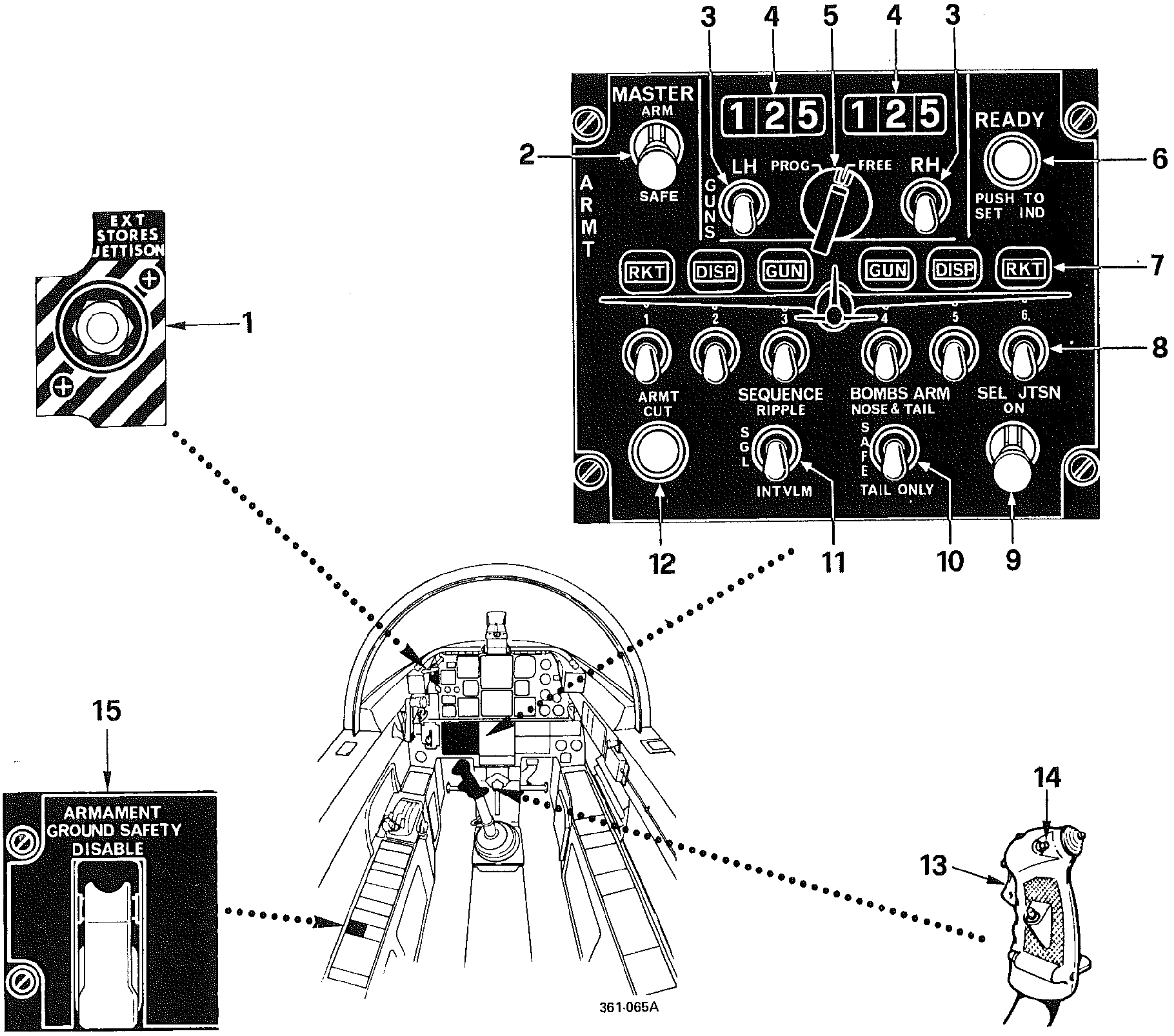


Figure 1-7. (Sheet 1)

ARMAMENT CONTROLS

NOMENCLATURE	FUNCTION
1. "EXT STORES JETTISON" push-button	Pressed - Causes immediate and simultaneous release of all external stores carried under the pylon.
2. "MASTER" switch	SAFE - All armament circuits are de-energized except for the simultaneous emergency release of the stores. An indication of the type of store suspended under each pylon can however be obtained by pressing the "READY" push-button. ARM - If the aircraft is in flight with the landing gear control lever UP. this position energizes all armament circuits. To pass from the SAFE to the ARM position, the switch toggle must first be pulled and then moved to the new position.
3. "GUN LH" and "GUN RH" switches.	Up - Arm the corresponding LH or RH cannon for operation.
4. Cannon rounds indicator	Provides indication of the rounds fired by each cannon.
5. Cannon operating mode selector switch	FREE - Free operation of the cannons. The cannons go on firing as long as the trigger on the control stick is held depressed. PROG - Programmed operation of the cannons. The cannons fire for a maximum time set on the ground (0.50 ±1 sec) even if the trigger is held depressed for a longer time.
6. "READY" caution light-push button	Pressed - Brings the marking identifying the type of store suspended under the pylon in view in the special windows of the external store indicators. The operation must be carried out with the MASTER switch at SAFE. Illuminated - When illuminated with green light, it indicates that at least one cannon or one store has been selected for operational use; when illuminated with amber light, it indicates that a store has been selected for emergency release.
7. External store indicator (one for each underwing station)	Displays the indication corresponding to the store carried under the pylon in a window arranged in the same position as the corresponding underwing station in the aircraft. The function of the indicator is to confirm that the armament circuits have actually identified the external store and are armed for the specific operation. The six indications appearing in each window are as follows: RKT (rocket container), BOMB (bomb), GUN (gun or minigun pod), DISP (container with at least one store to be dropped), EMPTY (container entirely empty) and TANK (underwing pylon tank). When no indication appears in the window (black background), no external store is suspended under the pylon.

Figure 1-7. (Sheet 2)

ARMAMENT CONTROLS

NOMENCLATURE	FUNCTION
8. Store arming switch (one for each underwing station)	UP - Arms the armament store that is desired to use for release and causes illumination of the green "READY" light (when "SEL JTSN" switch is OFF). Arming can only be obtained if the "MASTER" switch is at ARM.
9. "SEL JTSN" switch	OFF - De-energized position. ON - When the release push-button on the control stick is pressed, any previously armed store is dropped in a safe condition. If an underwing station is selected for store release, the light incorporated in the "READY" push-button becomes amber. If bombs are dropped through this circuit, the relevant fuzes are unarmed whichever is the position of the "BOMBS ARM" selector switch. To pass from the OFF to the ON position, the "SEL JTSN" switch toggle must first be pulled and then moved to the new position.
10. "BOMBS ARM" switch	SAFE - Safe release of the bomb with no armed fuze. NOSE & TAIL - Both nose and tail fuzes are armed. TAIL ONLY - The tail fuze only is armed.
11. "SEQUENCE" switch	Permits selecting the sequence for firing of rockets from containers or release of bombs, flares or smoke cartridges from containers. SGL - A single rocket is fired or a single flare is dropped from each selected underwing station every time the control stick push-button is pressed. RIPPLE - When the pilot presses the push-button, all rockets contained in the selected containers are fired in a very rapid sequence. If other store containers are selected in lieu of the rocket containers, the function of the RIPPLE position is identical to that of the SGL position. INTVLM - Inoperative
12. "ARMT" caution light	Illuminated - Indicates that the cannon safety connector (outside the cabin) is in the SAFE position.
13. Cannons or machine guns firing trigger	Pressed - Permits firing with cannons or machine guns selected through the control panel. The trigger has two detent positions: • First detent position - Operation of gun camera • Second detent position - Operation of gun camera and firing of cannons or machine guns.

Figure 1-7. (Sheet 3)

ARMAMENT CONTROLS

NOMENCLATURE	FUNCTION
14. Rocket firing or bomb release push-button	Pressed - Permits firing or dropping all stores selected and armed through the control panel.
15. "ARMAMENT GROUND SAFE-DISABLE" switch	Guard and toggle held up - Cuts out the safety micro-switches actuated by the landing gear control lever and allows ground testing of the armament system.

Figure 1-7. (Sheet 4)

PART 3 - OPTICAL SIGHT SYSTEM

AERITALIA 8-105-924 GUNSIGHT (Aircraft [B]

The Aeritalia gunsight, Part No. 8.105.924, (figure 1-8) is a wide field reflecting equipment intended for use in aircraft. The standard configuration is supplied with an adjustable mount which provides control in azimuth and elevation. The optical system consists of a single Mangin mirror, an illuminated reticle, and a semitransparent combining glass, which is adjustable in azimuth.

The equipment consists of a light alloy casing on top of which the lighting bulbs and the reticle are mounted.

Two quarz bulbs, rated 25 W and 28 V maximum, enclosed in an easily removable box for ease of lamps replacement, are provided for the illumination of the instrument.

A selecting switch is provided on the left side of the casing in order to employ the desired lamp. A rheostat is provided on the right side of the casing to dim the light of the selected lamp.

The standard reticle is shown in figure 1-9.

The combining glass is pivoted on both sides of the chassis and the angular displacement is obtained by means of a cam-sliding block device.

Located on the left hand side of the casing, the cam control knob on which a front visible scale is engraved, permits the reading in milliradians of the depression angle to be performed.

The lighting of the scale is obtained by means of a lamp located inside the control knob and replaceable from outside.

The mangin mirror is situated inside the base of the casing.

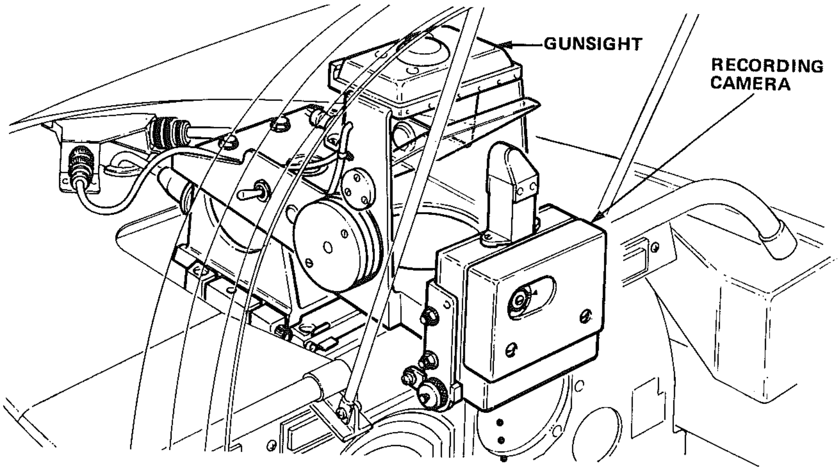
The casing with all the optical system, is mounted on the support which is adjustable both in azimuth and elevation.

This support is locked after completion of adjusting procedures on aircraft.

When the OMERA AA-8-30 recording camera is used guides are mounted allowing the camera to be easily attached and removed.

The light emitted by the lamps illuminates

AERITALIA 8-105-924 GUNSIGHT [B] AIRCRAFT



NOTE
GUNSIGHT OPERATING CONTROLS ARE ILLUSTRATED AND DESCRIBED IN FIGURE 1-16.

Figure 1-8.

the reticle which is located on the focal plane of the mangin mirror.
The light beams, after crossing the combining glass, reach the manging mirror that reflects them towards the top of the instrument.
A portion of these light beams is at the same time reflected by the combining glass towards the operator.
The mangin mirror, assigned to produce an image at infinity of the reticle, has been designed to minimize spherical aberration of the system.
The operator can sight directly the target and the lighted image of the reticle superimposed on it projected by the optical system as above described.
The visual field is such as to allow binocular vision in a wide field of view without affecting the accuracy of the aim.
The field within which the observer's eye can range is 80 x 80 mm.
When the recording camera is used, the field of view is partially reduced in elevation.
In such a case, a portion of the light beams coming both from reticle and target, enters the objective of the camera which records the accuracy of the aim.
The control knob allows to set depression values up to 200 mils. Nevertheless it may be difficult for the pilot to position his head in front of the sight to aim at the target with more than 150 mils set.
It is advisable therefore to set on the sighting head the calculated sight-setting less 50 mils and aim (instead of the center dot) at the intersection of the lower edge of the sighting circle with the vertical bar. See point A in figure 1-9.

AERITALIA 8-105-924 GUNSIGHT

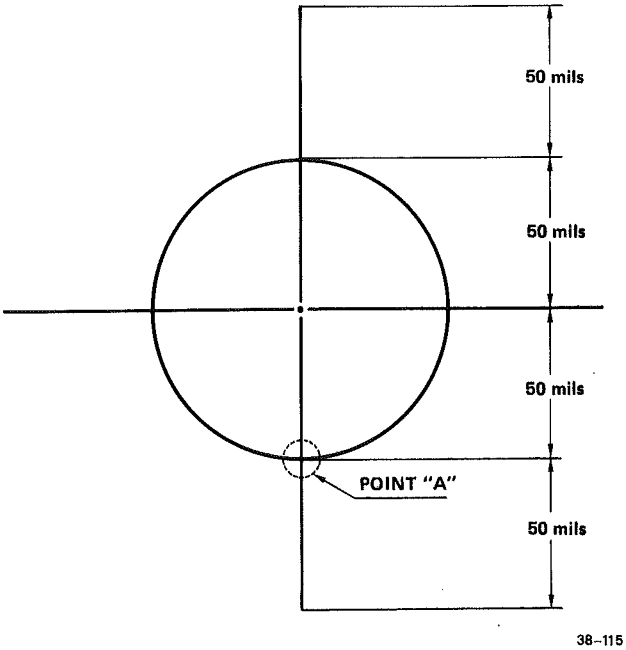


Figure 1-9.

THOMSON R322Z(M) GUNSIGHT SYSTEM (Aircraft [A])

The Thomson R322Z(M) gunsight system (figure 1-10) is mainly composed of:

a. Sighting head with gyro controlled aiming display.

b. Range control actuated by twisting the engine throttle grip.

c. Control box which permits the selection of the "mode" of employment of the sighting head and the setting of cross-wind correction.

d. Junction box for electric cables connection in order to link the sighting head to the control box, the range control and the aircraft electrical power.

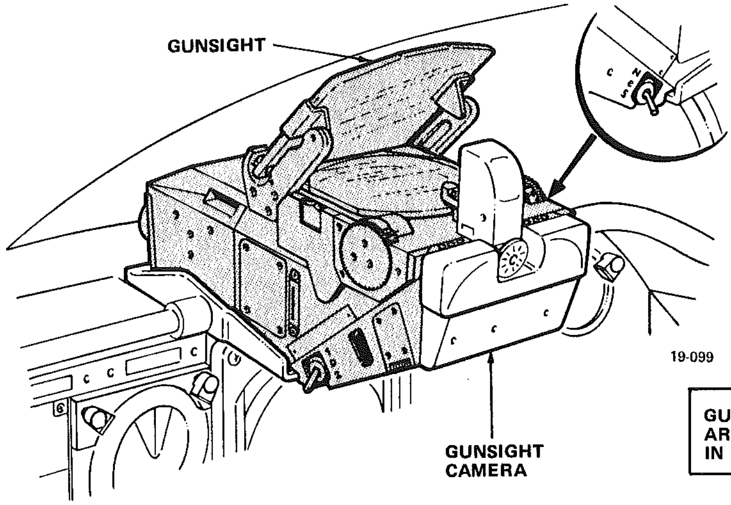
The R322Z(M) system is energized by:

- 28 VDC from the primary DC bus bar through the "SIGHT & GUN CAMERA" circuit breaker (7-1/2 A).
- 115 VAC, 400 Hz from the primary AC bus bar through the "SIGHT" circuit breaker (2 A).

The sighting head comprises the gyro casing which houses the gyro-motor, the fixed and the slaved mirror, the gyro deflection coils, the lenses, the reticles and the illumination bulbs. The case supports the reflector glass mounting on its top, the gun camera attachment in the front-face and the controls as follows:

- N-E switch. Allows to select the normal "N" or the emergency "E" bulb to illuminate the reticles.
- Target wing span knob. Allows to set the target dimensions.
- Brighteness adjusting knob. Allows to control the brightness of the two aiming reticles.
- Depression knob. Allows to set the desired sight depression, for all air-to-ground modes, from 0 to 100 mils in 2-mil increments.

THOMSON R322Z(M) GUNSIGHT **[A] AIRCRAFT**



NOTE
GUNSIGHT OPERATING CONTROLS ARE ILLUSTRATED AND DESCRIBED IN FIGURE 1-13.

Figure 1-10.

The "T" switch and the altitude holding advisory lights are not operative.

OPERATION OF THOMSON R322Z(M) GUNSIGHT

The pilot aiming at the target through the reflector glass can see the image of two reticles, both projected to infinity whose brightness can be controlled from zero to a maximum by means of a "brightness command knob" set at the lower left corner of the sighting head.
The aiming graticule is represented in figure 1-11 and displays a centre dot of 2 mils diameter surrounded by 6 diamond-shaped markers.
The diameter of the circle inscribing the six diamonds is variable from 7.5 to 63 mils and its size is controlled by twisting the throttle handle in order to obtain the measurement of the distance from the target by making equal the size of target (wing span) and the diameter of the diamonds circle. To obtain the required distance it is necessary to pre-set the target wing span on the appropriate knob.
The above mentioned distance can be read on a moving scale appearing on the lower edge of the reflector glass and marked in tens of yards from 200 to 900 yards.
The aiming graticule shown in fig. 1-11 is positioned on the reflector glass as a function of the distance and angular velocity of the fighter in "pursuit curve" to follow the target.

THOMSON R322Z(M) GUNSIGHT – – GYRO CONTROLLED RETICLE

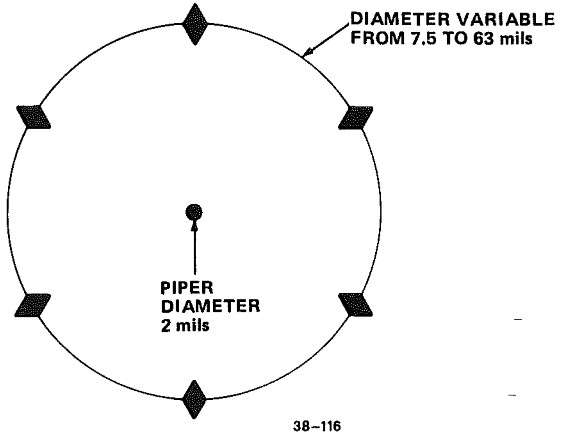


Figure 1-11.

Also the gravity drop along the true vertical is corrected, by means of a pick-UP from the vertical gyro of the aircraft, therefore the aiming through the "pipper" is very accurate in an aerial attach performed not very far from the standard 2.5 g pursuit curve and 408 KTAS of the fighter.
Superimposed to the reflector glass there is also a fixed reticle for reference, pipper alignment and missile launching purpose (figure 1-12).
The "CROSS" on the top of the figure may be used as air-to-ground aiming point for

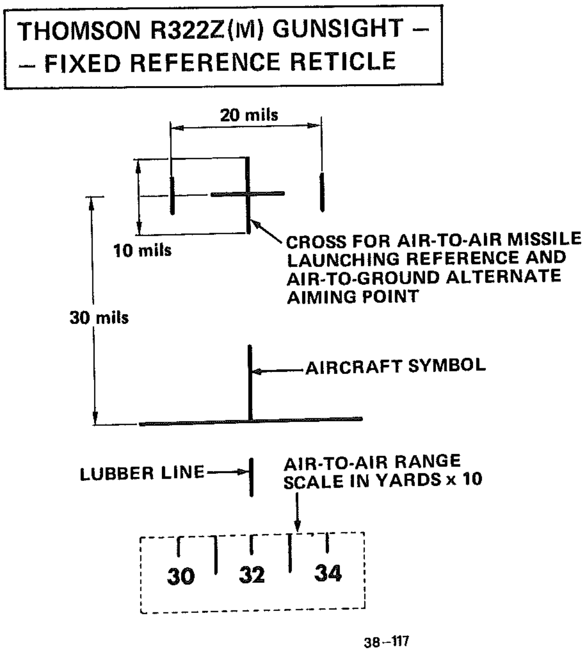

THOMSON R322Z(M) GUNSIGHT –
– FIXED REFERENCE RETICLE
20 mils
10 mils
30 mils
CROSS FOR AIR-TO-AIR MISSILE LAUNCHING REFERENCE AND AIR-TO-GROUND ALTERNATE AIMING POINT
AIRCRAFT SYMBOL
LUBBER LINE
AIR-TO-AIR RANGE SCALE IN YARDS x 10
30
32
34
38–117

Figure 1-12.

cannon and gun attack in case of malfunction of the gyro controlled reticle. The "AIRCRAFT SYMBOL" help the pilot to materialize the angle of bank during the attack and the moving range scale can be read, against the lubber line (in tens of yards). When the sight is properly working and the aircraft is still on the ground, or in level and unaccelerated flight, the "pipper" of the aiming reticle, will appear superimposed to the center if the reference "CROSS" when a sight depression of 7.5 mils is set to zero cross wind and G, R, or B1 Mode. The range control is described in Item 14. Manual telemetry is obtained by rotating the engine throttle grip.
It is possible to pass immediatly from any "Mode" of attack to G-AA (Guns-Air to Air) by pressing the SIGHT push button on the throttle grip. (The AUTO G-AA button on the control box will illuminate).
To return on the pre-selected Mode it is necessary to press the illuminated AUTO G-AA button the light of which will go off. The control box is described in figure 1-13.
The correction factors for cross wind component in air to ground modes are as follows:

- Mode G (Guns) = 0.35 kt for each knot crosswind
- Mode R (Rockets) = 0.40 kt for each knot crosswind
- Mode B1 (Bombs = 1.00 kt for each knot crosswind
- Mode B2 (Bombs) = 1.00 kt for each knot crosswind
- Mode HD (Bombs-High drag, para- or Snakeye) = 1.70 kt for each knot crosswind

To perform an air-to-ground attach in windy condition it is necessary to set the headwind or tailwind correction as an increment or decrement of the sight setting value on the depression knob (figure 1-13, item 5) and correct for crosswind component acting on "CROSSWIND" knob of the control box (figure 1-13, item 2).

THOMSON-CSF RD21 GUNSIGHT (Aircraft [B])

The Thomson-CSF gunsight, type RD21, (figure 1-14) is composed of a sighting head displaying to the pilot a marker as a bright cue projected at infinity to achieve air-to-air and air-to-ground firing. The gunsight is a compact equipment whose weight is approximately 4.5 kg (10 lb). The sighting head contains the optical system units, a gyroscope of the GGS type and a reticle. No caging device is provided for the gyro.
It comprises:

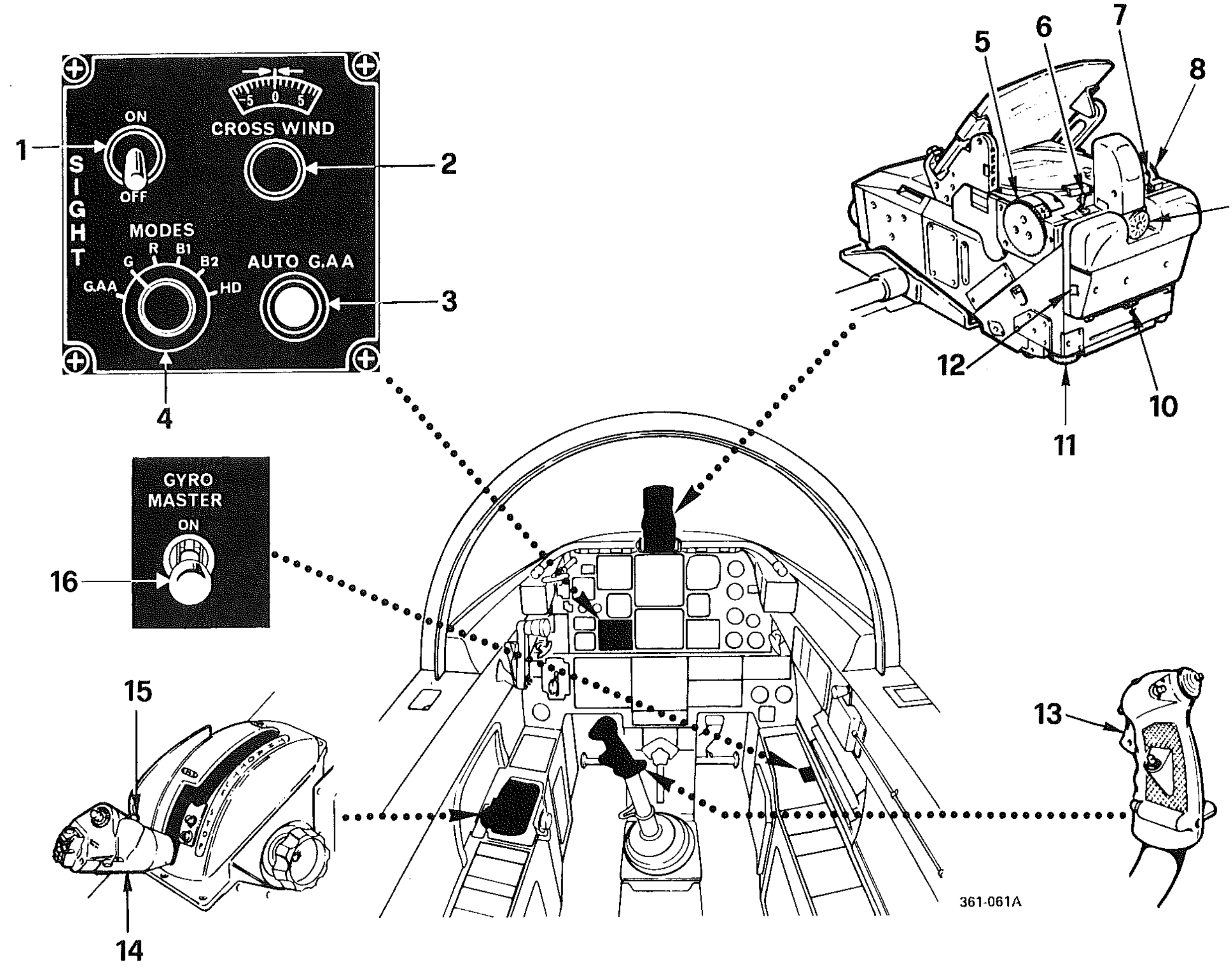
- A "MODE" selector switch
- A manual depression angle control
- A reticle brightness control knob
- A "NORMAL/STANDBY" bulb selection switch
- An air-to-air "RANGE" selection switch
- A fixation device for the sighting recorder (Omera-Segid AA8-30)
- A time meter for checking gyro operation time
- A connector

The base plate of the gunsight comprises a bolt enabling the fixation onto the aircraft structure.
A neoprene pad may be mounted on the sighting head plate facing the pilot. The Omera-Segid sighting recorder (AA8-30) may be substituted for this cushion using the same attachment.

OPERATIONS OF THOMSON RD21 GUNSIGHT

The gunsight is supplied from the 28 Vdc primary bus bar through the SIGHT & GUN CAMERA circuit breaker, and its operation

THOMSON R322Z(M) GUNSIGHT AND GUN CAMERA CONTROLS [A] AIRCRAFT



NOMENCLATURE	FUNCTION
1. "ON-OFF" switch	OFF - De-energized. ON - Activates the gunsight system.
2. "CROSS WIND" knob	Puts in the correction for the cross wind component. The datum set by the knob appears in a window above the knob and is comprised in a range from 0 to 40 knots both to left and right. When the gunsight is operating in the GAA mode, the correction is not introduced.
3. "AUTO GAA" light-push-button	Pressed - Restores operation of the gunsight in the pre-selected mode after pre-selection had been excluded by operation of the "SIGHT" push-button.

Figure 1-13 (Sheet 1)

THOMSON R322Z(M) GUNSIGHT AND GUN CAMERA CONTROLS [A] AIRCRAFT

NOMENCLATURE	FUNCTION
	Illuminated - Indicates, when the "SIGHT" push-button has been pressed, and the mode selector switch is in a position other than GAA, that the operating mode is in "air to air".
4. "MODES" selector switch	Sets the gunsight for operation in the following modes: GAA - Air-to-air firing with cannons. G - Air-to-ground firing with cannons. R - Firing of rockets. B1 - Release of bombs, depression from 0 to 100 mils. B2 - Release of bombs, depression from 100 to 200 mils. HD - Release of high drag bombs, depression from 100 to 200 mils.
5. Depression knob	Allows to set the desired depression. The indication is comprised between 0 to 100 mils in 2 mil increments.
6. "T" switch	T (Test) - The three altitude lights illuminate. (The related system, normally connected with a radio altimeter, is inoperative on this aircraft).
7. "E - N" switch	N (Normal) - The reticle is illuminated by the normal bulb. E (Emergency) - Causes illumination of an emergency bulb to illuminate the reticle in case of failure of the normal bulb.
8. Target wing span knob	Allows to set the target dimension in a range from 20 to 100 ft with 2 ft increments.
9. Film speed adjusting knob.	Sets the number of the gun camera frames per second.
10. Overrun control knob	Sets the camera to operate for a period of time after the firing trigger has been released.
11. Brightness adjusting knob.	Adjust the reticle light intensity.
12. Film indicator	Green - Film available Red - Film completely exposed
13. Gun camera trigger	Pulled to the first detent position - Operates the gun camera.

Figure 1-13. (Sheet 2)

THOMSON R322Z(M) GUNSIGHT AND GUN CAMERA CONTROLS [A] AIRCRAFT

NOMENCLATURE	FUNCTION
14. Distance meter	Manual telemetry is obtained by rotating the engine throttle grip. The distance value between aircraft and target is read in yards on a movable scale appearing in the gunsight reflector glass. The grip is spring-loaded to the full counterclockwise position.
15. "SIGHT" push-button	Pressed - Provides immediate operation of the gunsight in the air-to-air (G.AA) mode for cannon firing whichever in the position of the MODES selector switch.
16. "GYRO MASTER" switch	OFF - De-energized position. ON - Operates the gyro system.

Figure 1-13. (Sheet 3)

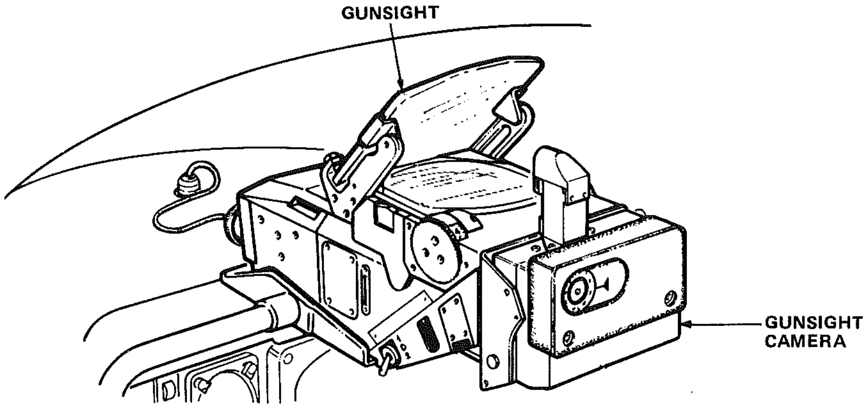
is controlled by the "MODE" selector switch, which is a drum located on the right upper part of the sighting head.

CAUTION

The gunsight must always be switched on prior to flight.

- On position "O" the gunsight is "OFF".
- On position "A.A." (Air-to-air) all circuits of the sighting head are on, the reticle is illuminated enabling AA gun firing according to the selected firing range set on the range selection switch.
- On position "G1" (ground 1) the sight-

THOMSON - CSF RD21 GUNSIGHT [B] AIRCRAFT



NOTE

GUNSIGHT OPERATING CONTROLS ARE ILLUSTRATED AND DESCRIBED IN FIGURE 1-16.

Figure 1-14.

ing head is ON, the reticle is illuminated and its elevation position can be adjusted inside a 100 mils range, by means of the manual depression angle control from 0 mils up to 100 mils downward with reference to ZSL.

- On position "G2" (ground 2) the sighting head is ON, the reticle is illuminated and its elevation position can be adjusted inside a 100 mils range, by means of the manual depression angle control, from 100 to 200 mils downwards with reference to ZSL.

The manual depression angle control drum is located on the left upper part of the sighting head and controls the elevation reticle displacement when the "Mode" selector switch is on position "G1" or "G2". The drum is graduated from 0 to 100 mils with a notch every 2 mils. The reticle is composed of a center dot and a circle of dots (fig. 1-15).

The circle is represented by twelve bright dots whose diameter is 0.9 mils; it is centered on a "pipper" dot whose diameter is 2 mils.

The reticle brightness knob is contained in the left lower part of the sighting head. Brightness can be adjusted from maximum brillance to extinction by continuous variation.

The reticle is illuminated by a high luminous efficiency bulb; should the normal bulb fail, it can be replaced by the standby one. The control switch is located on the right lower part of the sighting head.

The upward position "N" is for normal bulb, the downward position "S" for the standby one.

The range selection switch is located on the left lower part of the sighting head. It enables selection of the two fighter-to-target ranges. When shifted upward in position "D1" 250 yards is selected, when shifted downward in position "D2" the selected range is 500 yards.

THOMSON - CSF RD21 GUNSIGHT RETICLE

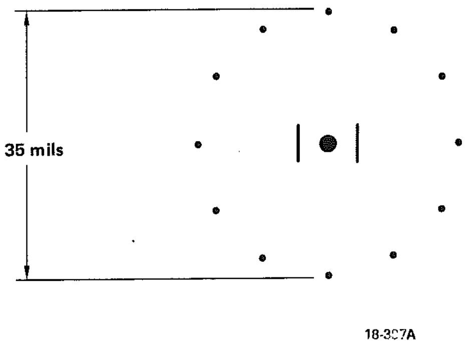


Figure 1-15.

Condition of use - in A.A. mode the gunsight delivers the target and gravity drop gyroscopic corrections for visual firing stabilized tracking mode (at least one second steady tracking) and for the following firing conditions:

- fixed ranges of 250 or 500 yards
- target speed 300 KIAS = 348 KTAS
- fighter speed 350 KIAS = 408 KTAS
- fighter load factor 2.5 g
- altitude 10 000 ft

Departure from these conditions will impair the accuracy of prediction.

In the air-to-ground modes the reticle position corresponds to the depression angle shown on the bombing, or launching tables, corrected for zero sight line angle of attack. Use position G1 of the "mode selector" for depression angles up to 100 mils and position G2 for depression angles from 100 to 200 mils.

After sight setting the pilot starts diving and aims the "pipper" at the target maintaining steady tracking for one second at least; when range, altitude and dive angle correspond to the intended conditions, the pilot releases the weapons.

OMERA-SEGID AA8-30-4 GUN CAMERA

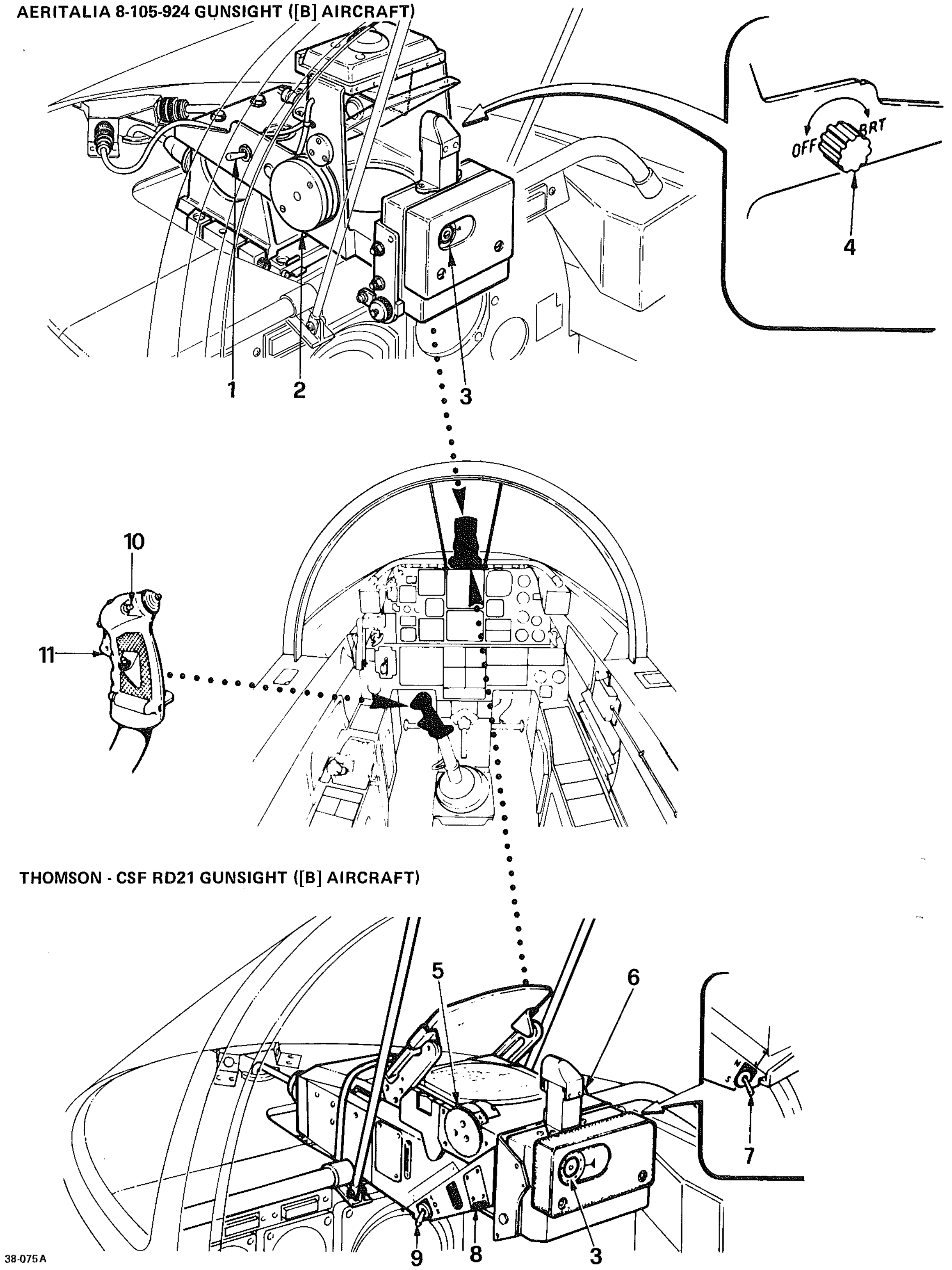
The Omera-Segid gun camera, type AA8-30-4 (fig. 1-16) is a 16 mm cine-camera with an electrically operated spool.

The gun camera, installed in front of the gunsight, automatically registers, through the reticle of the gunsight, the results of gun and rocket firing. The body of the camera contains a 28 V motor whose speed of rotation is maintained constant by a centrifugal regulator.

Through a reduction gear the motor drives:

- The film feed sprocket.
- A shutter, adjustable by an external knob on the camera.
- By means of a clutch, the spool on which the exposed film is wound.
- A counter, graduated from 0 to 3 m which indicates to the pilot the quantity of film which remains to be exposed.

AERITALIA 8-105-924 & THOMSON - CSF RD21 GUNSIGHT AND GUN CAMERA CONTROLS


AERITALIA 8-105-924 GUNSIGHT ([B] AIRCRAFT)

THOMSON - CSF RD21 GUNSIGHT ([B] AIRCRAFT)

38-075A

Figure 1-16. (Sheet 1)

AERITALIA 8-105-924 & THOMSON - CSF RD21 GUNSIGHT AND GUN CAMERA CONTROLS

NOMENCLATURE	FUNCTION
1. "LAMP" switch	N1 - Selects one of the two lamps for reticle illumination. N2 - Selects the second lamp (reserve lamp of the first one).
2. "MILS" depression knob	Rotated - Allows to set the desired depression. The indication is comprised between 0 and 100 mils in 5-mils increments.
3. Shutter aperture control	Rotated - Adjusts the shutter aperture between 1/100 and 1/1200 of second.
4. "OFF/BRT" rheostat	OFF - De-energized position. Rotated toward BRT - Reticle brightness can be adjusted from total extintion to maximum brillance by continuous variation.
5. Depression knob	Rotated - Allows to set the desired depression. The indication is comprised between 0 and 100 mils in 2-mils increments.
6. Mode selector	0 (OFF) - De-energized position. A.A. (Air to Air) - Air-to-air gunfire with sighting in stabilized tracking mode. G_1 (Ground 1) - Air-to-ground attack with guns, rockets. G_2 (Ground 2) - Air-to-ground attack with bombs.
7. "N/S" switch	N (Normal) - Selects the main lamp for reticle illumination. S (Stand-by) - Selects the stand-by lamp for reticle illumination.
8. Reticle brightness knob	Rotated - Reticle brightness can be adjusted from total extintion to maximum brillance by continuous variation.
9. "1/D/2" switch	Enables selection of the two fighter-to-target ranges in "A.A." mode. 1 - 250 yards range. 2 - 500 yards range.
10. Bomb release button	Depressed - Operates the gun camera
11. Gun trigger	Pulled - Operates the gun camera

Figure 1-16. (Sheet 2)

The gun camera comprises:

- A S.F.O.M. lens of 30.4 mm focus with an aperture of f/4.0.
- A total reflection prism, located in front of the lens which makes a vertical exposure possible.
- A shutter with a setting adjustable from 1/60 to 1/400 second. The gun camera has a film speed of 6 frames per second.

OPERATION OF GUN CAMERA SYSTEM

The gun camera system receives power from the 28 V dc primary bus bar through the "SIGHT & GUN CAMERA" circuit breaker and is controlled by the firing trigger and the bomb & rocket release button on the stick grip.

The gun camera has an automatic overrun up to 60 s after the release of the trigger or the bomb/rocket button.

Since no device is provided for separate operation of the gun camera and the armament when the armament is released, the gun camera will always operate.

Pressing the cannon/gun firing trigger to the first detent position closes the circuit to the gun camera motor only. Pressing the firing trigger to the second detent position causes the cannons and/or whatever type of underwing machine gun selected on the armament panel to be fired while the gun camera keeps on running.

To make a dry run with the gun camera operating, the "MASTER" switch must be on the SAFE position: it is advisable to pull also the two "GUNS" switches and the six "STORE ARMING" switches in the OFF position.

PART 4 - MUNITION SUSPENSION SYSTEM

GENERAL

The aircraft is designed to carry a wide range of weapon combinations. It is fitted with six strong points of underwing attachment (three stations on each mainplane numbered from 1 to 6, starting from the end of the left mainplane) (see figure 1-17). These attachment points permit the installation of machine gun pods (station 3 and 4) and pylons for external loads of various types.

The pylons used on the underwing attachments for carrying the external loads are of the Aermacchi type with Handley-Brown rack, type MA-4A, fitted with suspension hooks at 14 in. centres.

CAUTION

> Any underwing store whose length, measured from the aft suspension lug to the tail of the store, exceeds 42 in. must not be suspended under station 3 and 4 because of the interference with the wing flaps when lowered in "Take--off" or in "Down" position.

UNDERWING PYLON INSTALLATION

The Macchi pylons GB900-20-36, to be attached to any of underwing station are designed to carry all the weapon combinations applicable to the MB326K() aircraft.

The pylons GB900-20-11 permit to install underwing fuel tank besides all the weapon combinations applicable to the aircraft. These pylons can only be fitted at stations 2 and 5. Each underwing strong point will carry a special pylon-to-wing fairing.

In addition to their load-carrying function, the pylons also provide for the electrical connection of the loads to the aircraft armament system. Sway braces are fitted to the pylons by pins.

The pylons are attached to the wing by means of a center post which engages a socket in the wing and by two adjustable locators (fig. 1-18).

MA-4A BOMB RACKS

All pylon structures contain an MA-4A bomb rack. The bomb rack is manually cocked and electrically activated. A sight window and an inspection hole are provided to allow the rack to be checked for proper engagement of the release lever locking arm and tumbles.

The pylon racks have suspension hooks, spaced 14 in. apart, that fit standard external stores suspension lugs (figure 1-19).

The pylon rack safety pin (figure 1-19) when fully inserted, assures that the bomb rack is mechanically safe.

STRONG POINTS OF UNDERWING ATTACHMENT

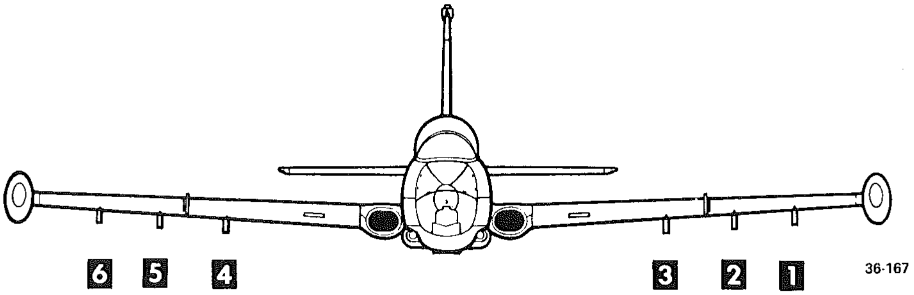


Figure 1-17.

UNDERWING PYLON

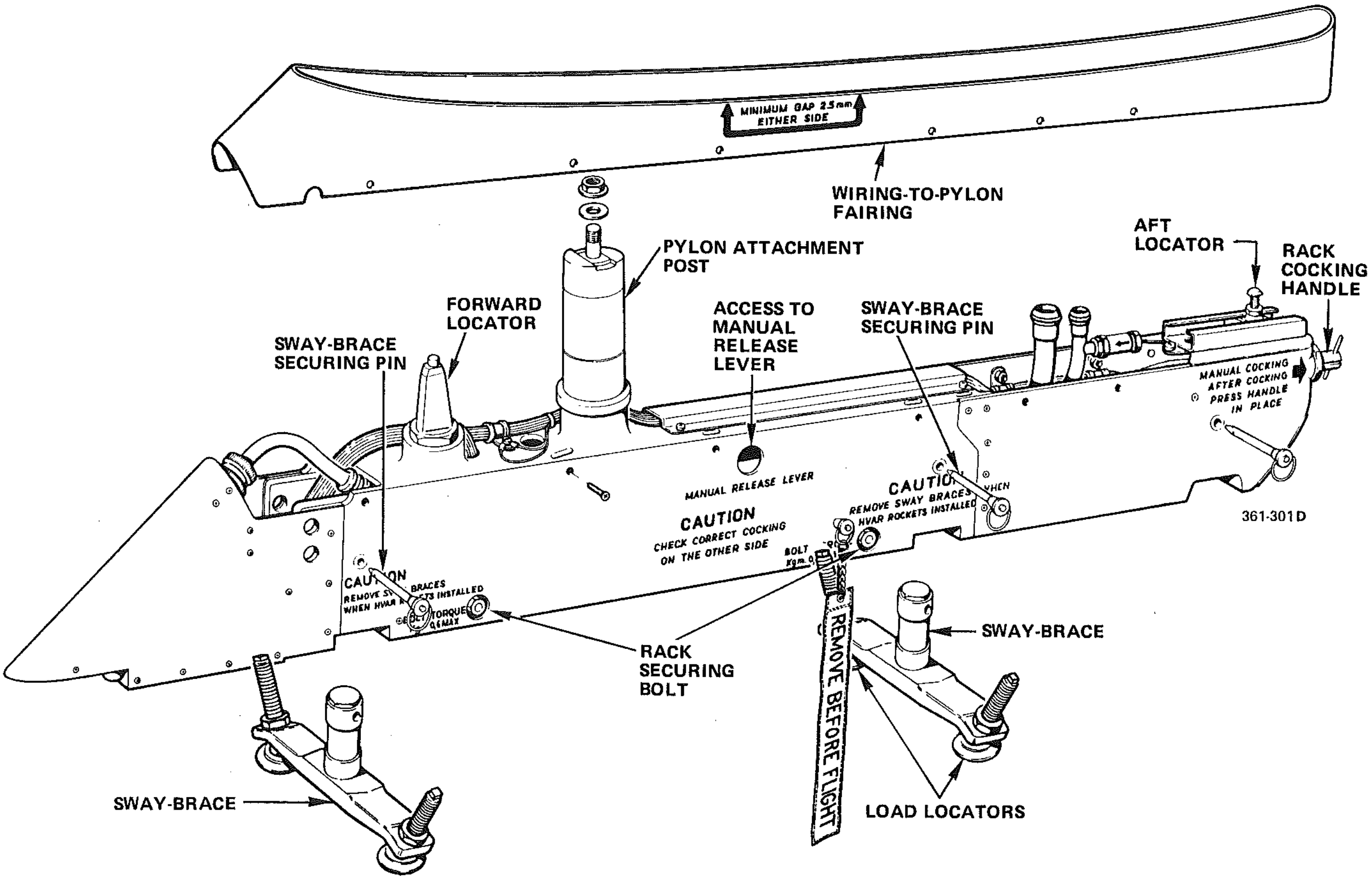

MINIMUM GAP 2.5mm EITHER SIDE
WIRING-TO-PYLON FAIRING
AFT LOCATOR
RACK COCKING HANDLE
PYLON ATTACHMENT POST
FORWARD LOCATOR
ACCESS TO MANUAL RELEASE LEVER
SWAY-BRACE SECURING PIN
SWAY-BRACE SECURING PIN
MANUAL COCKING AFTER COCKING PRESS HANDLE IN PLACE
MANUAL RELEASE LEVER
CAUTION CHECK CORRECT COCKING ON THE OTHER SIDE
CAUTION REMOVE SWAY BRACES WHEN HVAR ROCKETS INSTALLED
BOLT Kgm
CAUTION REMOVE SWAY BRACES WHEN HVAR ROCKETS INSTALLED
BOLT TORQUE 0.6 MAX
361-301D
RACK SECURING BOLT
SWAY-BRACE
REMOVE BEFORE FLIGHT
LOAD LOCATORS
SWAY-BRACE

Figure 1-18.

Arming Solenoids

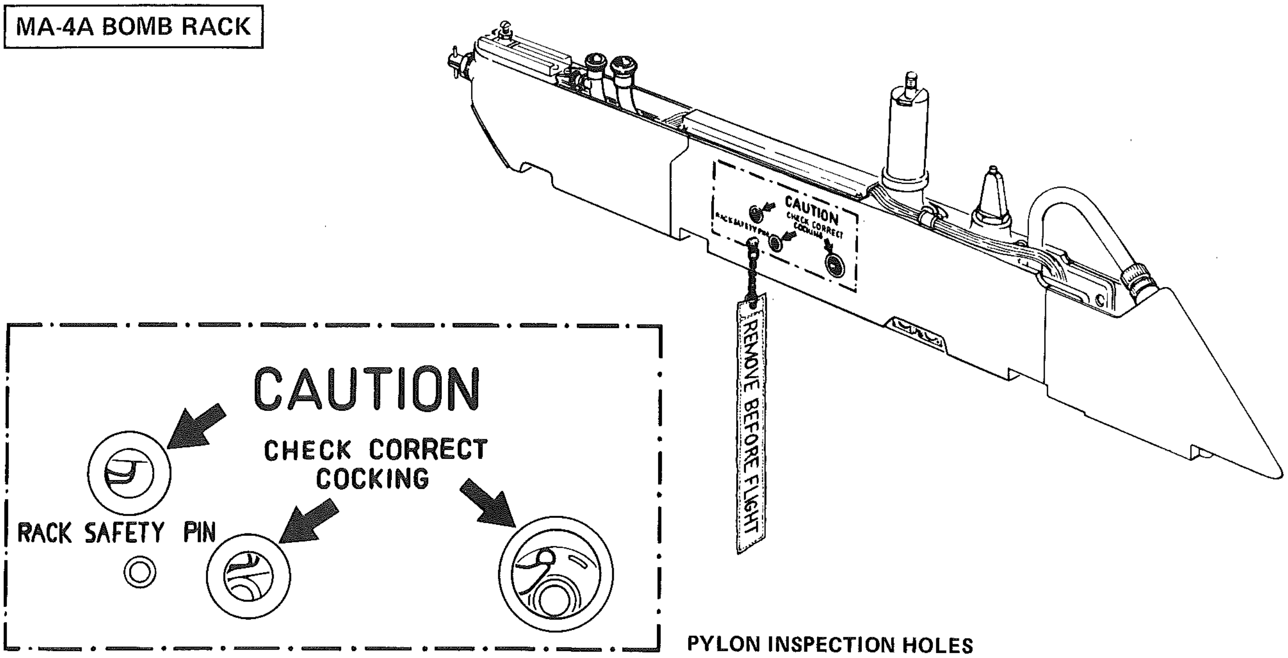
Two solenoids contained in the rack permit the engagement of the bomb fuse arming cables. The solenoids are energized by selections of the "FUSE" switch on the cockpit armament control panel. Although not used in the MB-326K( ) aircraft, for standardization pulpose only, other two solenoids are set in the nose section of the pylon to permit the arming of the nose fuse of the HVAR (instant). The tail fuse of HVAR rocket is always automatically armed when the rocket propulsion motor is ignited.

EXTERNAL LOADING CONFIGURATION LIMITATIONS

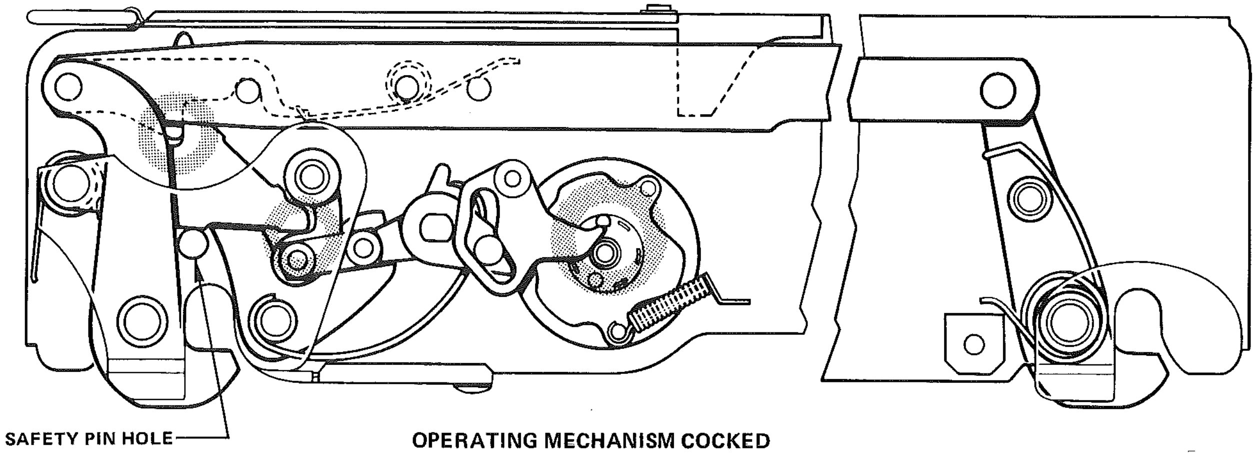
The approved external stores (weapons, pods and fuel tanks) and the stations on which these stores may be loaded are shown in the FLIGHT MANUAL, Section V. This figure also gives the speed and acceleration limits not to be exceeded by the aircraft when fitted with the various external stores.

Without knowing all the factors that affect the acceptability of a loading configuration, one might assume that two apparently similar configurations could be accepted, when one of them is listed as approved. Such as assumption, however, is dangerous. The effects of externally carried stores on the aircraft must be considered, the same as for any other high performance aircraft. All factors which can affect acceptability of loading configurations and limitations for the aircraft, such as structural, flutter, aerodynamic, and CG limitations, and controllability requirements, must be considered in determining acceptability of any loading configuration.

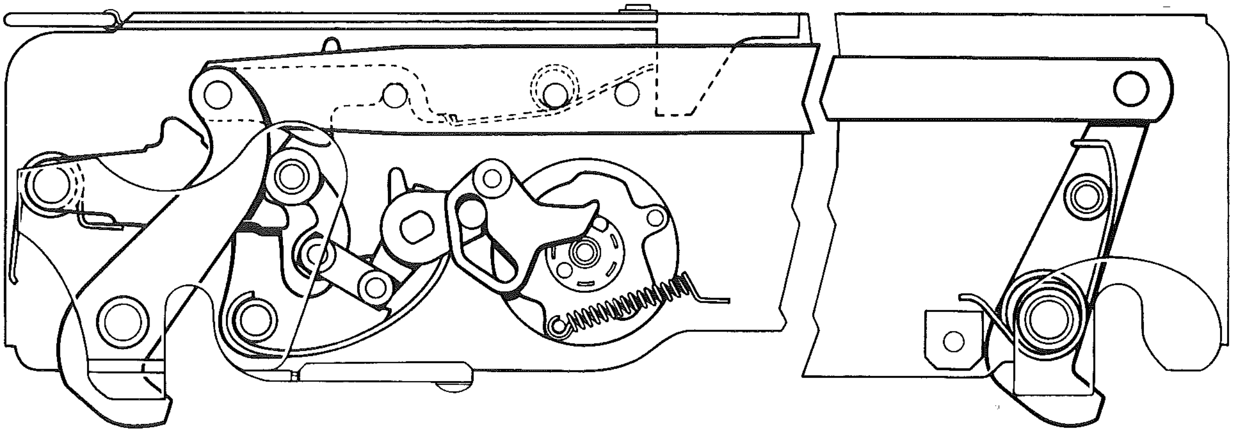
MA-4A BOMB RACK



PYLON INSPECTION HOLES



OPERATING MECHANISM COCKED



OPERATING MECHANISM RELEASED

Figure 1-19.

FACTORS AFFECTING ACCEPTABILITY OF LOADING CONFIGURATIONS

The following discussion considers only those factors that affect the aircraft flying capabilities. Every configuration must possess satisfactory aircraft longitudinal stability and control characteristics. For this, each configuration considered must be examined to see that the aircraft in-flight CG travel, due to use of internal and external fuel and expenditure of weapons and ammunition, stays within the established CG limits of the configuration throughout the flight envelope.

Destablizing effects of external stores of the same weight vary with their size, shape, whether the stores have fins, fore-and-aft, lateral, and vertical locations with respect to the aircraft wing and fuselage. Even the same store could vary its destabilizing effect, depending on its location on the wing.

The analysis required to determine acceptability of loading configurations must consider each weapons flight limits, the aircraft flight limitations when carrying the stores, and the desired sequence for releasing external stores and selecting the external tank fuel. In addition, the analysis considers single failure conditions, such as failure of an external store to release or an external fuel tank to transfer. These effects on configuration acceptability must also be examined to determine if any special limitations or operational procedure is necessary to maintain aircraft CG position within limits.

WARNING

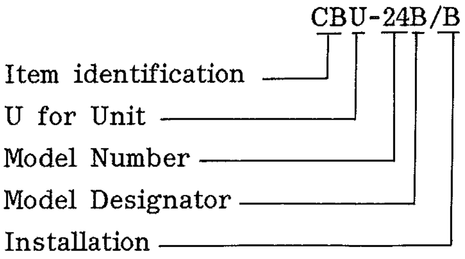
Stores not yet qualified MUST NOT BE USED until Aermacchi qualification trials and calculations will be completed and the stores reported, with the relevant flight limitations, in the Flight Manual.

PART 5 - MUNITIONS (COMBAT)

GENERAL

Commensurate with structural integrity of the suspension system, each aircraft may be loaded to its maximum allowable limit for the applicable weapon. Weapon locations are shown with respect to fuselage and underwing stations. For the permissible approved loading configurations, consult the figure "External Stores" in the applicable Flight Manual.
The total external store drag number for each weapon load configuration, including the accessories (pylon, adapters, and launchers), depends on the size and shape of the weapon and associated accessories. The aircraft gross weight will affect the angle of attack (thus sight depression angle); therefore, it should be computed as accurately as possible. The weapon illustrations provide the individual weapon weight and the total weight of all suspension equipment required for an individual station. The dive bombing sample problem in Section V illustrates the aircraft gross weight computation.

USAF MUNITIONS CODING



Munitions Identification Designators

BD	Simulated Bombs
BL	Bombs and Mines
CB	End Item Cluster Bombs
FM	Munition Fuzes
GA	Aircraft Guns
LA	Aircraft Installed Launchers
MA	Miscellaneous Armament Items
SU	Stores Suspension and Release Items
WD	Warheads

Installation Designators

A	Aircraft Installed, Fixed Installation or may be expendend on mission
B	Aircraft Installed, must be expended on mission

DEFA TYPE 553 CANNON SYSTEM (fig. 1-20)

The airplanes are equipped with two DEFA Type 553, caliber 30 mm, cannons located side by side in the lower part of the fuselage.
The guns are recoil-operated and the rounds are electrically fired. A pyrotechnic device provides automatically one rearm for each gun in case of misfire.
Power is supplied by the 28 V dc secondary bus bar.
The system includes ammunition storage capacity of two 125-round boxes. Other 25 rounds can be stowed in the ammunition belt guide. Gas purging during and after gunfire operation in flight is made by ram air.
No purging is provided during ground fire operation. A round counter informs the pilot of the remaining ammunitions.
The cannons must be charged on the ground. When the cannons are fired cases are ejected overboard and links are discharged into a container.
The cannon operation is electrically controlled through the control box 30-550-F3 (CRL1) in order to obtain:

- unlimited fire or,
- bursts limited to 1 s or 0.5 s,
- interdiction of fire under some circumstances.

CAL 30 mm AMMUNITION (fig. 1-21)

The ammunition fired in the DEFA type 553, 30 mm are defined as "Class 550" and are linked in belts with separable steel links type 51.

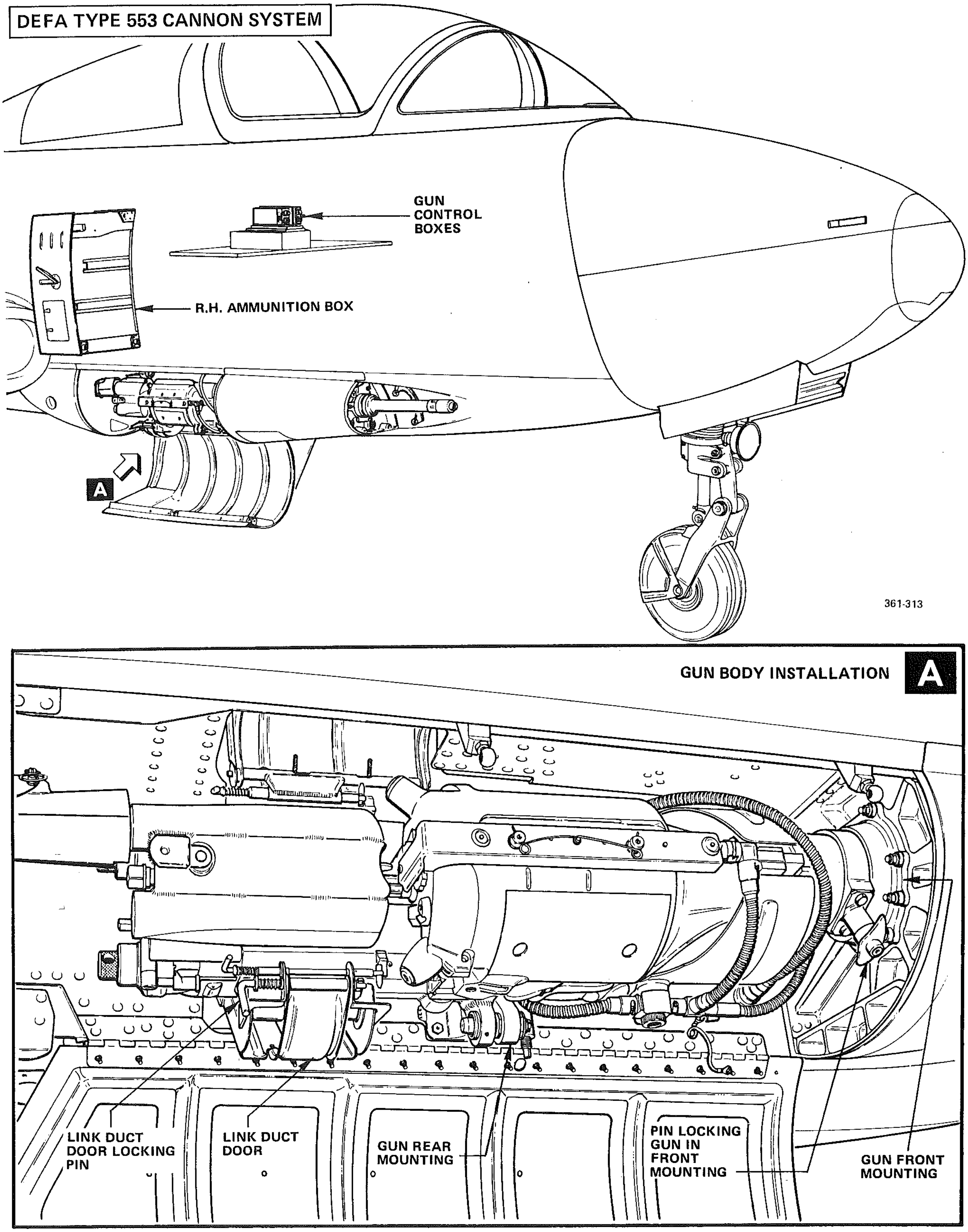

DEFA TYPE 553 CANNON SYSTEM
GUN CONTROL BOXES
R.H. AMMUNITION BOX
A
361-313
GUN BODY INSTALLATION
A
LINK DUCT DOOR LOCKING PIN
LINK DUCT DOOR
GUN REAR MOUNTING
PIN LOCKING GUN IN FRONT MOUNTING
GUN FRONT MOUNTING

Figure 1-20.

CAL 30 mm AMMUNITION AND LINK

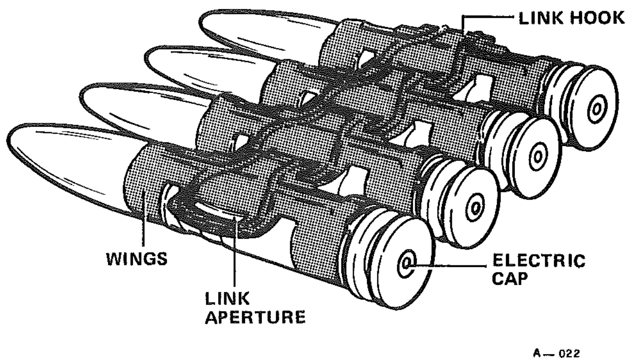


Figure 1-21.

NOTE

> Links type 50 can be also supplied by the Manufacturer but MUST not be used on standard MB-326K( ) aircraft. Links type 50 are dimensionally different from standard type 51, therefore a special modification is required of the link ejection duct dimension to allow a free, undisturbed movement of expended links type 50.

All "Class 550" ammunition have approximately the same ballistics and mass.

The setting of the ammunition on the belt is different, with respect to the side of the gun ammunition feed (on the right or on the left).

TYPE 6522 TA AND 6522 FA AIR TO AIR AMMUNITION

Belts are composed in sequence as follows:

1 rounds FA (driving band made of roasted iron with de-coppering effect) and 5 rounds TA (copper driving band).

The projectile of the AIR-AIR, type 6522, service ammunition is a thin-wall shell with a high explosive capacity.

It operates mainly through blast effect and incendiary power, the effects of which are increased by the delay of the fuze operation. This ammunition is used in AIR-TO-AIR combat in which the appropriate organization of its self-destruct, percussion fuze permits to obtain good results.

The AIR-AIR ammunition contains an important charge of high explosive (Hexal), which garants it a blast effect particularly efficient against aircraft structures.

Moreover the intense heat evolved by this explosive produces an aluminothermy on the sheets of the target which sets fire to the aircraft combustible elements (namely fuel). Finally, an important fragment effect makes of the 30 mm AIR-AIR ammunition a highly destructive shell.

The AIR-AIR, type 6522, service ammunition is fitted with the percussion, self-destruct 1511 M fuze (figure 1-22). This fuze, designed for Air-to-Air firing, may be used also in Air-to-Ground firing. It operates through discharge and is fitted with a mechanical self-destructive device.

The fuze head (1) includes all the components of the fuze itself. It is obturated at its front end by a closing plate (2) set in the head.

The firing-pin block (15), consisting of the firing-pin (3) set in its support (4) (the latter being set itself in the firing-pin block (5)) as well as the self-destructive device, including 8 balls (6), the conical ring (7) and the pressure springs (8), (together with the spiral (12), are made up of the outside (9) and inside (10) spirals, maintained in place in the head by the primer base (11).

The delay detonator (13) is located in the housing designed for this purpose in the primer base.

A cardboard slacking-gasket (14) ensures its fixing. The delay detonator, loaded with lead-penthrite nitride, includes a baffle delay mechanical device on the one hand, and on the other hand, a special delay composition, the combined effect of which creates a delayed operation within approx. 1 meter.

At rest, the firing block (15) is maintained in place by the pressure ring (8) and the spiral (12) positioned by the dowel of the primer base (11).

When the shot is fired, as long as the projectile undergoes positive acceleration, that is to say beyond the barrel, the firing-pin block presses on the spiral and prevents its uncoiling.

When the acceleration is over, and under the effect of the centrifugal force, the spiral uncoils and flattens itself against the vertical wall of the primer base (11), thus entirely freeing the firing-pin block orifice. It is considered that the spiral is completely uncoiled and the fuze armed only at a distance of 4 to 5 meters after going out of the muzzle.

On the other hand and at the same time, the spin velocity being high enough, the balls (6) go up the pitch of the conical ring

DEFA 1511M FUZE

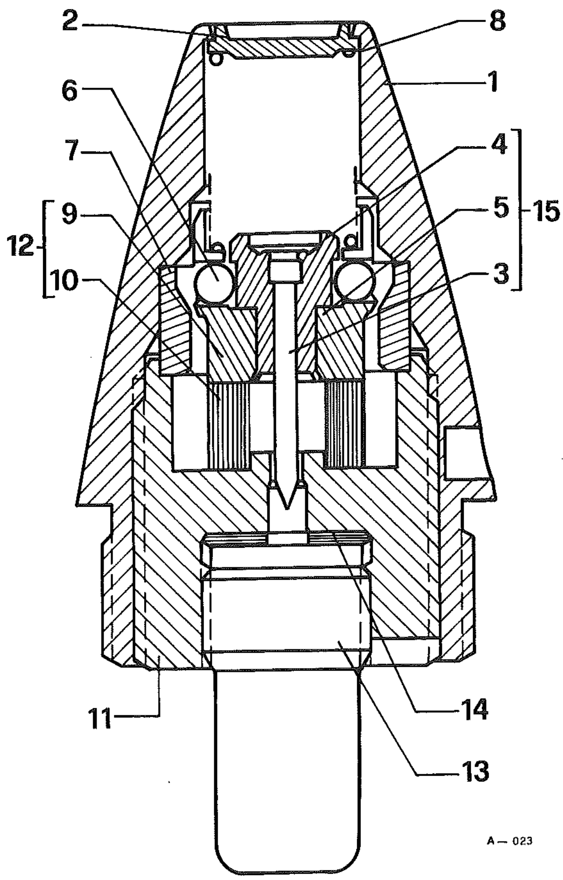


Figure 1-22.

(7) and, counterbalancing the action of the pressure spring (8), maintain the firing-pin block in a position very slightly higher than the one it occupied at rest.
When the projectile hits the target, the closing plate (2) is pushed backwards. Through the spring, the balls (6) stand aside and the firing-pin block comes to strike the primer of the detonator (13). Should the projectile fail to hit the target, when the spin velocity has decreased and when the centrifugal force on the balls has become lower that the strength of the pressure spring, the latter projects the firing-pin block onto the primer of the detonator, which results in destroying the projectile before its reaching the ground.
The fuze is designed so that the self-destruction happens between 7 and 15 seconds. This sel-destruction is produced by the action of a mechanical system, based on the decrease of the spin velocity of the projectile.

The fuze operation is delayed so that the blast effect and the shell fragments may have their maximum efficiency inside an aircraft cockpit or structure, the lenght of the delay being approx. 1 millisecond. The fuze can safely operate under temperature conditions included in between +60°C and -60°C.

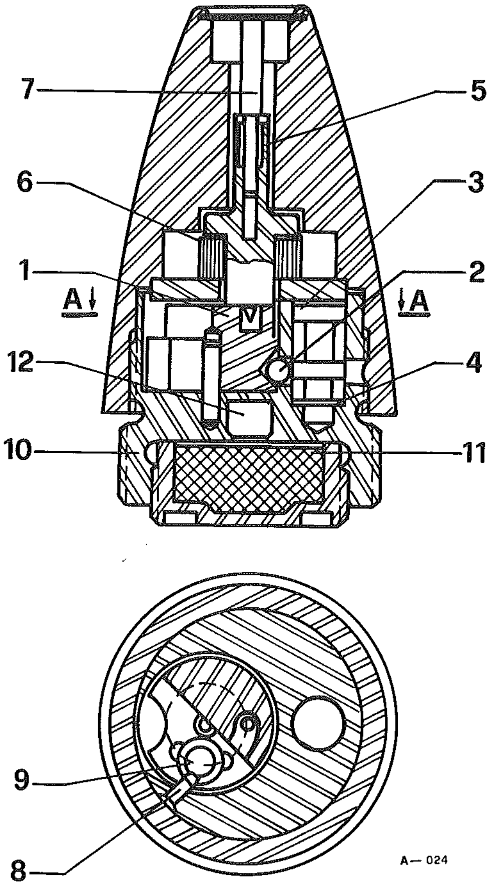
Safety Devices

The fuze does not work when the cartridge (500 grams approx.) falls upside down from a height of 5 m onto a rigid steel plate. The fuze cannot work during the acceleration time and against a target located at less than 3 m from the muzzle.
The fuze does not work on 2 mm drops of water at a velocity of 800 m/s.
The fuze does not work in the case of a double-feed of the weapon. However, under the very strong action of the feed-mechanism, the fuze is seriously damaged. On the other hand, should the cartridge remain in a very hot tube, the detonator does not set off.

TYPE 5432 TA AND 5432 FA AIR TO GROUND AMMUNITION

Belts are composed in sequence as follows: One round FA (driving band made of roasted iron with decoppering effect) and five rounds TA (copper driving band).
The projectile of the Air-Ground, type 5432, service ammunition is an anti-personnel shell also effective in light target blasting.
Its fragments may perforate this plates. This ammunition is used in Air-to-Ground combat by jet-planes up to a 1500 m range. It has been especially designed to act through fragment effect. However, it can also be used in Air-to-Air missions in which the effect of its fragments are interesting. The mixing with Air-Air ammunition is possible, both exterior ballistics being absolutely identical.
This ammunition is designed to act through anti-personnel and anti-vehicle effect, which accounts for the volume of the explosive being smaller and the metal coating bigger.
The number of fragments big enough to be effective is important. The perforating strength upon impact is very high, which makes of this shell a higly efficient projectile against utility vehicles, including armored personnel carriers.
The Air-Ground, type 5432, ammunition is fitted with the instantaneous 1520 fuze without self-destruction. It operates

DEFA 1520 FUZE



SECTION A-A

Figure 1-23.

through set-back.

The type 1520 fuze (figure 1-23) includes a rotor (1) the axis of which is set over in relation to the longitudinal axis of the fuze. This rotor is brought to a standstill, at rest, by a ball (2), which is in turn locked up by an inertia block (3) backed up by a closing-disc (4). The collar (5) of the firing-pin (7) rests on a spiral ribbon (6) of non-elastic metal. A snug (8) set in the wall is provided to limit the spin of the rotor (1).

The pyrotechnical priming elements are:

- the main percussion primer (9) borne by the rotor,
- the subordinate primer (12) located in the body (10),
- the booster.

At rest, the percussion primer (9) borne by the rotor (1) is off center, therefore the igniter train is broken. The percussion of the primer (9) cannot happen in this stocking and handling position, even in the two following cases:

- should the fuze fall upside down,
- should the weapon be double-fed at high rate of fire.

Should the main percussion primer operate at a wrong time (in case of fire for instance), the gases cannot reach the subordinate primer (12) owing to the occlusion of the pipe. Therefore the break system of the igniter train is fully reliable.

During the acceleration phase (projectile travelling through the tube), the intertia block (3) operates the closing-disc (4) and goes deep into its housing, thus allowing the ball (2) to escape under the action of the centrifugal force towards the central part of the inertia block.

The rotor (1) is at the same time kept in position by its own longitudinal inertia and that of the iring-pin collar (7) exercising a pressure upon it. The spiral (6), undergoing centrifugal force, cannot uncoil completely owing to the stronger longitudinal acceleration, which flattens it against its bearing. Therefore the fuze is inert when travelling through the tube.

When the projectile has been fired, the deceleration phase begins. The firing-pin collar (5) and the firing-pin itself (7) move onwards, thus freeing the rotor (1). The latter, which is unbalanced, revolves under the action of the centrifugal force acting on the unbalance and comes to lie upon the snug (8) which moderates its spin movement.

The main primer (9) is then in line under the point of the firing-pin collar and above the subordinate primer.

At the same time, the spiral (6), undergoing the deceleration of translation and the very strong centrifugal force, uncoils under the action of this force and flattens itself against the wall of its housing. The spin delay of the rotor and the spiral uncoiling allow the projectile to run away before arming (muzzle safety). The fuze is armed.

Upon impact, the firing-pin (7) pushes back the collar (5), the point of which strikes the primer (9). The report of the latter bursts the wall which separates it from the subordinate primer (12). The latter is then stirred up and in its turn detonates the booster (11).

Other, newer type, Air-to-Ground ammuntion DEFA cal. 30 mm are:

- CART 30-550-OPIT-T5960*	Armor Piercing, Incendiary, Tracer
- CART 30-550-OATEI-T5460*	Antipersonnel, explosive, incendiary and the General Purpose ammunition
- CART 30-550-OMEI-T7560*	Explosive, Incendiary

The above mentioned munitions are to be used in homogeneous belts.
For pratice munitions see Part 7 "Training Weapons and Equipment" later.

GUNNERY SYSTEM - 30 mm GUN POD MACCHI 39A-940-31/32 (fig. 1-24)

The aircraft embodying wing modification as per DWG PROT41557 can carry gun pods Ref. No. 39A-940-31 and 39A-940-32 at underwing stations 3 and 4 respectively.

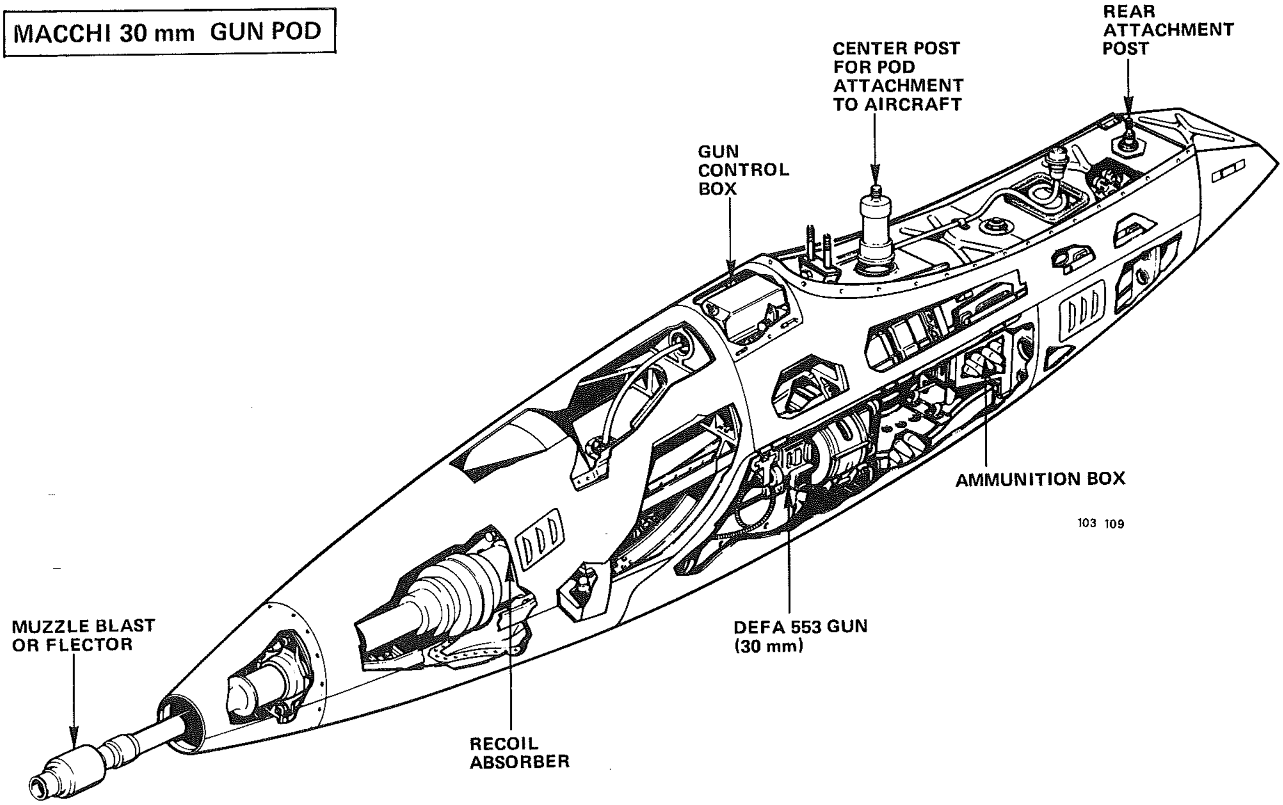


Figure 1-24.

The 30 mm gun pod is specifically designed for use on air-to-ground firing missions, but it can effectively be used for air-to-air firing.

It is essentially a container of good aerodynamic shape which provides accomodation for a 30 mm DEFA type 553 cannon associated parts, and 130 round linked in a belt. Expended cartridges are ejected overboard; expended links are collected into a container.

Further information on Gun Pod are contained in pubblication P.I. 11W1-2-1.

Ammunition loading instructions and firing tables are identical to those related to the DEFA type 553 internal cannons.

GUNNERY SYSTEM - MINIGUN POD TYPE SUU-11( )/A

The gunnery system allows the concurrent installation of six minigun pods to be fitted under the wing by means of the pylons at station No. 1, 2, 3, 4, 5 and 6.

Firing of the minigun pods is possible only on condition that either the landing gear control lever is set at UP (aircraft in flight with the landing gear retracted) or the "GROUND FIRE" switch is held in the ON position. To arm the system for minigun firing, it is necessary that the "FWD ARMT" selector switch on the armament control panel be set to GUNS. Besides, the arming push-button of the pylons carrying the minigun pods must be depressed and the forward armament safety switch must be turned to ARMT & CAM. This last action will cause the lights incorporated in the previously selected arming push-buttons to light up and indicate that the system is armed for firing. Under these conditions, pushing the trigger on the front control stick grip to bottom is sufficient to fire the miniguns.

Pushing the firing trigger energizes relays which in turn energize the motor relay located in the minigun pod.

Current from the battery located in the minigun pod passes through the relay contacts to the motor which rotates the six barrels, trips the firing mechanism and fires the weapon. Releasing the trigger opens the circuuit and the weapon ceases to fire. The "GUN PWR" switch must be in the ON position to provide operation of the recharging and heating circuit in the minigun pod.

CAUTION

Recharging of the minigun pod batteries from the aircraft electrical system is possible on two pods. If more than two pods are installed, leave battery recharging connected to two pods only and disconnect the remaining pods by the appropriate battery switch.

SUU-11( )/A GUN POD

The SUU-11( )/A gun pod (figure 1-25) is a self contained GAU-2B/A gun system, adaptable to aircraft with bomb racks having front and rear suspension hooks spaced 14 in. apart.

INSTALLATION OF SUU-11 ( )/A MINIGUN POD

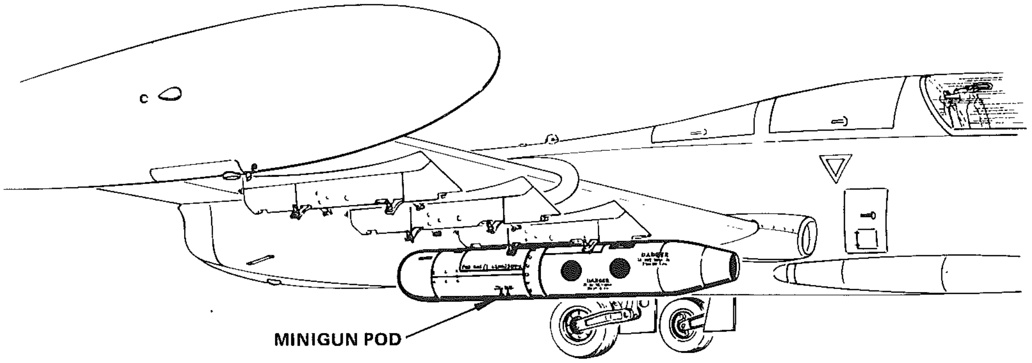


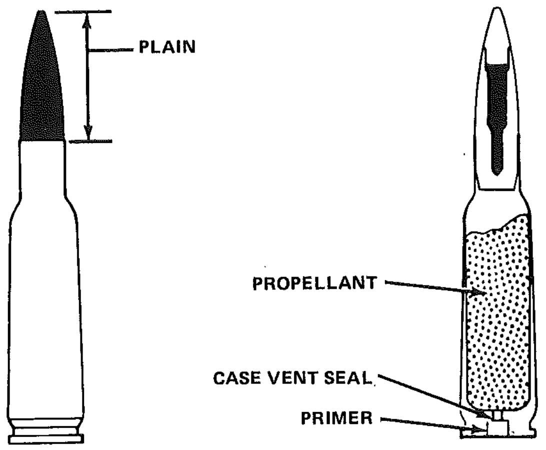
Figure 1-25.

CAL 7.62 mm AMMUNITION

M-59 AND M-80 BALL

MASS, COMPLETE ROUND	.350 grains
MASS, PROJECTILE	150.5 grains
LENGTH, COMPLETE ROUND	2.796 in.
LENGTH, CARTRIDGE CASE	2.000 in.
LENGTH, PROJECTILE	1.109 in.
DIAMATER, PROJECTILE	0.308 in.

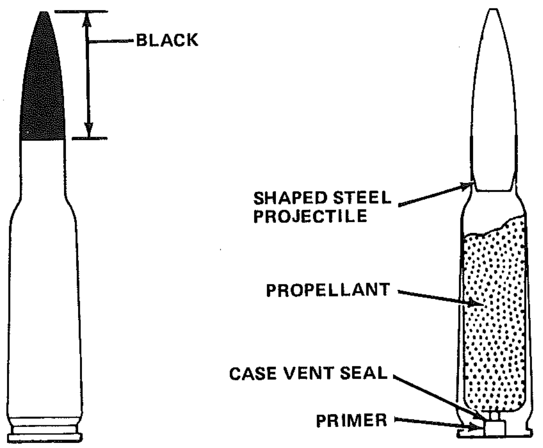
MIL-C-46277



M-61 ARMOR-PIERCING

MASS, COMPLETE ROUND	.335 grains
MASS, PROJECTILE	150.5 grains
LENGTH, COMPLETE ROUND	2.796 in.
LENGTH, CARTRIDGE CASE	2.000 in.
LENGTH, PROJECTILE	1.109 in.
DIAMETER, PROJECTILE	0.308 in.

FA-PD-SP-1955



M-62 TRACER

MASS, COMPLETE ROUND	.330 grains
MASS, PROJECTILE	.141 grains
LENGTH, COMPLETE ROUND	2.796 in.
LENGTH, CARTRIDGE CASE	2.000 in.
LENGTH, PROJECTILE	1.109 in.
DIAMETER, PROJECTILE	0.308 in.

FA-PD-MI-2541

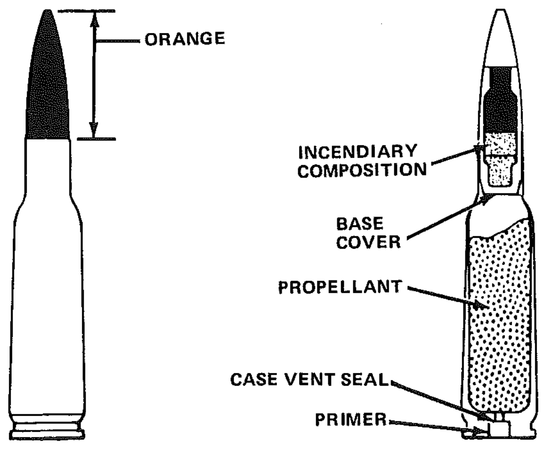


Figure 1-26.

The gun is secured in, and housed by, the pod. The pod may be used on aircraft with airspeeds up to Mach 1.20. The main components of the pod are the front fairing assembly, ammunition loader assembly, feeder assembly, recoil adapter assemblies, electric drive assembly, rounds counter, exit unit assembly, rear fairing assembly, battery and control assembly, support assembly, drive assembly, and drum assembly. The gun pod weights approximately 245 lb empty and 325 lb loaded. It is 85-inch long and is 12-inch in diameter. The pod has an ammunition capacity of 1500 rounds.

A toggle switch located inside the minigun pod can be set, prior the flight, to control the rate of fire either 6000 or 3000 rounds per minute.

The usable ammunition in the pod may be completely fired with a single burst, or fired in short bursts. Empty cartridges are ejected from the bottom of the pod.

NOTE

> SUU-11A/A is similar to SUU-11B/A but has a fixed firing rate of 6000 rounds per minute.

CAL 7.62 mm AMMUNITION (fig. 1-26)

All 7.62 mm ammunition for the GAU-2B/A gun (used in SUU-11( )/A gun pod) is classified as NATO ammunition and is issued in the form of "fixed ammunition". A complete round, known as a cartridge, consists of a cartridge case, a projectile (bullet), propellant powder and a primer.

The M59 or M80 7.62 mm ball cartridge is used in normal firing. The projectile consists of gilding material, body and filler. The body, made of steel, is hollow, and contains lead filler. The brass cartridge is loaded with approximately 47.0 grains of propellant and contains a primer. The tip is plain for identification.

The M61 7.62 mm armor-piercing cartridge is used against armored targets, functioning with a penetration effect. The body of the projectile is a solid shot made from bar alloy steel. The cartridge case is made of brass and is loaded with approximately 47.0 grains of propellant and contains a primer. The tip is black for identification.

The M62 7.62 mm tracer cartridge is used to provide indication of flight trajectory to the target so that sight picture adjustment may be made for correction in firing runs. The projectile consists of gilding material, body and filler, nose and rotating band. The body is made of steel, is hollows, and contains a pyrotechnic material that burns in flight. The brass cartridge case is loaded with approximately 44.4 grains of propellant and contains a primer.

The tip is orange for identification.

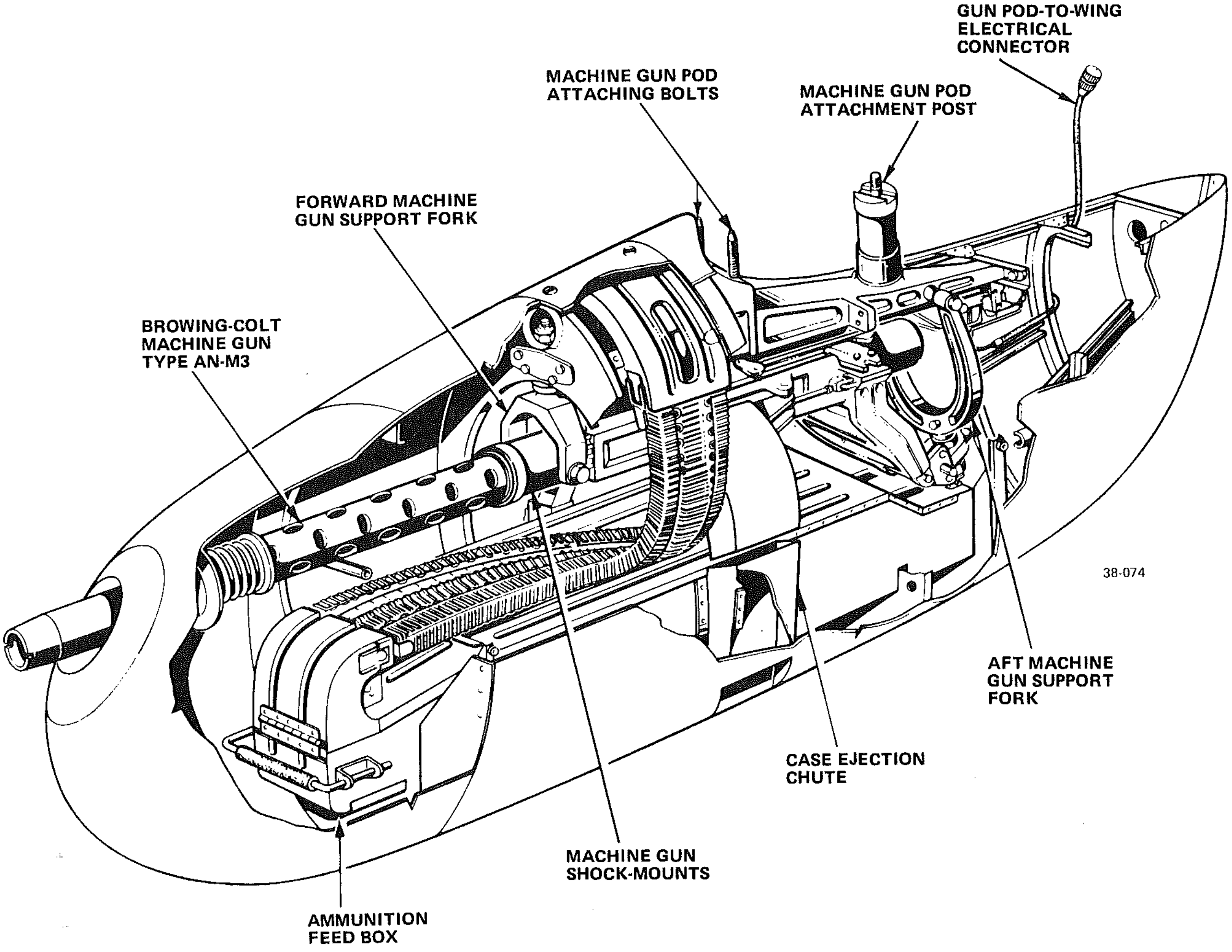
GUNNERY SYSTEM - MACHINE GUN POD MACCHI M910-21-10 AND M910-22-10 (fig. 1-27)

The machine gun pods M910-21-10 and M910-22-10 can be installed under the wing at stations 3 and 4. Each machine gun has a feed system under which there is a detachable ammuntion box containing 350 rounds including those in the flexible duct. Each weapon has an electrical heating system. The ammunition belt is fed to the gun by a feed mechanism driven by an electrical motor, which ensures continutiy of the feed even during aircraft manoeuvers. The maximum load factor compatible with correct ammunition feeding is 4 g. On the electrical drive motor mounting bracket, there is a microswitch which cuts off the current from the motor whenever overfeeding occurs i.e. rounds in excess of the weapon rate of fire. When overfeeding ceases, the microswitch automatically restores normal working conditions.

Firing of the machine gun is possible only on condition that either the landing gear control lever is set UP (aircraft in flight with the landing gear retracted) or the "GROUND FIRE" switch is held in the ON position. To arm the system for machine gun firing it is necessary that the "FWD ARMT" selector switch on the armament control panel be set to GUNS. Besides, the arming push-buttons of the pylons carrying the machine gun pods must be depressed and the forward armament safety switch must be turned to ARMT & CAM. This last action will cause the lights incorporated in the previously selected arming push-buttons to light up and indicate that the system is armed for firing. Under these conditions, squeezing the trigger on the control stick grip to the second detent position is sufficient to fire the machine guns and supply power to the boost motor relay via the relevant microswitch. Energization of the boost motore relay allows power to be supplied to the machine gun ammunition boost motor. The machine gun heater will be turned on as necessary by means of the "GUN PWR" switch on the armament control panel.

Pod M910-21-10 can be installed at wing station 3, pod M910-22-10 can be installed at wing station 4.

MACCHI MACHINE GUN POD


GUN POD-TO-WING ELECTRICAL CONNECTOR
MACHINE GUN POD ATTACHING BOLTS
MACHINE GUN POD ATTACHMENT POST
FORWARD MACHINE GUN SUPPORT FORK
BROWING-COLT MACHINE GUN TYPE AN-M3
38-074
AFT MACHINE GUN SUPPORT FORK
CASE EJECTION CHUTE
MACHINE GUN SHOCK-MOUNTS
AMMUNITION FEED BOX

MASS, EMPTY	168 lb
AMMO (350 ROUNDS)	100 lb
MASS, LOADED	268 lb
LENGTH	87.6 in.
WIDTH	14.2 in.
HEIGHT	23.3 in.

Figure 1-27.

AN-M3 CAL .50 MACHINE GUN

The function of the machine gun pod is to house a Browing-Colt type AN-M3 machine gun and relevant accessories.
The caliber .50 AN-M3 is a fully automatic, recoil-operated and air-cooled weapon. It develops a muzzle velocity of 2870 ft per second and fires at a rate of 1200 rounds per minute, using disintegrating-type ammunition belts cases and links which are ejected overboard.
By proper repositioning of the parts, it is possible to feed the gun from either the right or the left side. The trigger mechanism is operated by an electrical solenoid. A heater is also provided on the gun to prevent possible gun misfiring due to jamming of the moving parts after a prolonged parking at low temperatures.

CAL .50 AMMUNITION (figure 1-28)

The variety of ammunition available for the caliber .50 machine gun makes this weapon a versatile and effective component of fighter armament. The types of projectiles, as shown in T.O. 11-1-31 are illustrated in figure 1-28.
For rapid identification, the various types of projectiles are tipped with characteristic color markings. However, dummy round are unpainted and are identified by means of three (or sometimes two) holes drilled into the side of the cartridge case.

BOMBING SYSTEM

This system is used to drop bombs suspended under the rack in the pylon.
The bombs are laterally stabilized by the sway braces. The two solenoids contained in the rack permit the engagement of the bomb fuse cocking cables.
Bomb release is possible only on condition that either the landing gear control lever is set at UP (aircraft in flight with the landing gear retracted) or the "GROUND FIRE" switch is held in the ON position (during ground tests).
To arm the system for bomb release it is necessary that the external Armament Safety Connector be set to READY, the store arming switches, on the Armament Panel, corresponding to the concerned bombs be set to UP, then the "MASTER" switch be set to ARM.
For ground operation of the system is also necessary to hold momentary ON the "ARMAMENT GROUND SAFETY DISABLE" switch.
The bomb fuzes are preset for arming by moving the "BOMBS ARM" switch to NOSE & TAIL or to TAIL ONLY position.

BOMBS

All explosive bomb for high speed aircraft must be fitted with conical fin type tail assembly.
The fin assembly is used to stabilize the bomb in flight and permits greater accuracy in bombing operations. The fin assembly must be mounted in the "X" configuration when the bomb is carried on the aircraft.
The arming condition of the bomb nose and tail fuzes is manually selected by the three-position bomb arm switch mounted in the armament panel. This switch controls the arming solenoids in the pylon rack and determines which arming wire swivel loop or loops will be released or retained with the pylon. Operation of the fuze commences upon release when the arming wires are withdrawn from the fuzes, permitting the fuzes to arm. Upon impact with the target, one or both fuzes operate, igniting the explosive train, which relays and amplifies the blast, in order to detonate the bursting charge of the bomb. If either fuze (nose or tail) malfunctions, the other will cause detonation of the bomb.

MK 81 AND MK 82 LOW DRAG GP BOMBS

The MK 81 and MK 82 low drag general purpose bombs (figure 1-29) are normally used for demolition operations. The two bombs are identical in construction and operation, and differ from standard general purpose (GP) bombs only in the size and shape of their nose sections. The bomb has a low air resistance in the transonic and supersonic speed ranges. The suspension lugs spaced 14 inches apart, are provided on the MK 81 and MK 82 bombs. The bomb body is filled with Tritonal 80-20 or H-6 high explosive. The MK 81 LDGP bomb is a 250-pound class bomb that contains 100 lb of explosive charge. The MK 82 LDGP bomb is a 500-pound class bomb that contains 192 lb of explosive. A fundamental characteristic of the explosive used is its relative insensitivity to ordinary shock and heat incident resulting from loading, handling and transport. Nose and tail cavities are provided for fuzing components, to insure reliability of functioning and to cause the desired effect, which may be blast, mining or fragmentation. Arming wires are threaded through safety devices in the fuze, thus

CAL .50 AMMUNITION

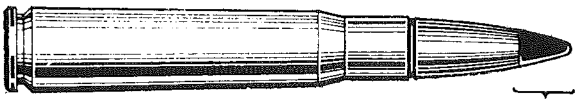
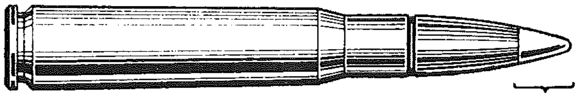
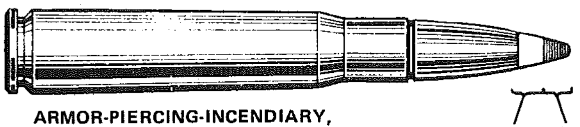
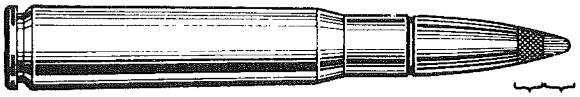
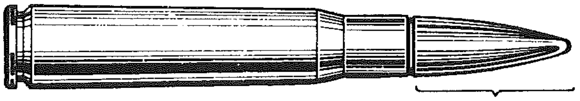
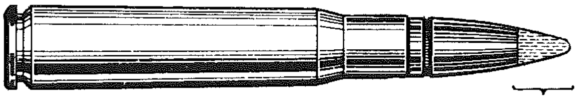
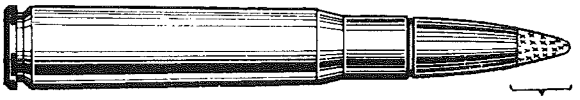
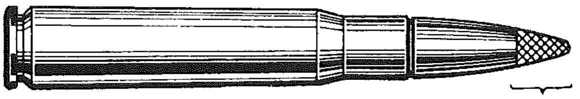
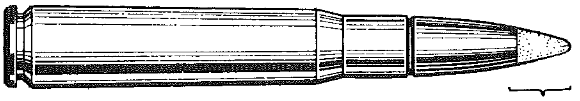
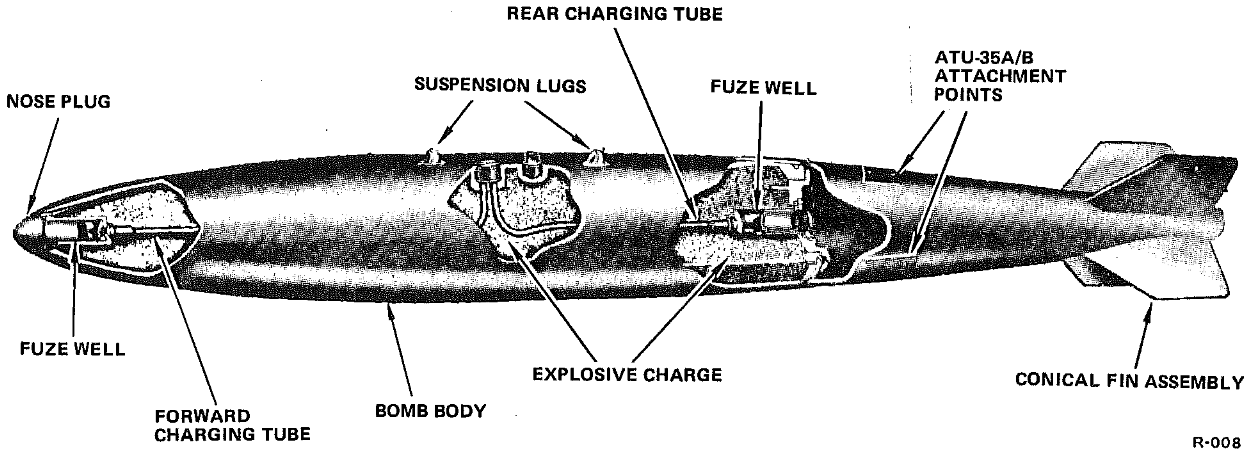
TYPE	FUNCTION
 **ARMOR-PIERCING, M2**	**For use against armored vehicles, locomotives and similar targets.**
 **ARMOR-PIERCING-INCENDIARY, M8**	**For use against armored, infiammable targets, such as fuel tanks.**
 **ARMOR-PIERCING-INCENDIARY, T49**	
 **ARMOR-PIERCING-INCENDIARY-TRACER, M20 (T28)**	**Dim trace to 300 yards and bright trace to 1750 yards.**
 **BAIL, M2**	**For use against personnel and light material targets.**
 **INCENDIARY, M1**	**For use against unarmored, infiammable or explosive targets.**
 **TRACER, M17 (T9)**	**Tracer burns for 2450 yards.**
 **TRACER, HEADLIGHT, M21 (T1E1)** **TRACER, M1**	**Tracer burns for 1800 yards. For training purposes only.** **Brilliant trace to 550 yards, visible from target.**
 **TRACER, M10**	**Dim trace to 225 yards, and bright trace to 1900 yards.**

Figure 1-28.

MK81 AND MK82 LOW DRAG BOMB



	MK-82	MK-81
MASS	531.0 lb	260 lb
LENGTH	90.5 in.	74.1 in.
DIAMETER	10.8 in.	9.0 in.
FIN SPAN	15.0 in.	12.6 in.
FUZE	Refer to Bomb-Fuze Compatibilty Chart (Fig. 1-61)	Refer to Bomb-Fuze Compatibility Chart (Fig. 1-61)

Figure 1-29.

maintaining the fuze in the safe (unarmed) condition until release. Adapter boosters, which are issued as separate units, serve to fill the 3 in. diameter fuze cavities, to accommodate the body of the fuzes, and to contain a booster charge which insures proper detonation of the high explosive charge. The MK 81 bomb uses the MK 81 fin; the MK 82 bombs uses the MK 82 fin. The fins are similar in shape but differ in size.

MK 82 LOW DRAG GP BOMB WITH M1A1 FUZE EXTENSION

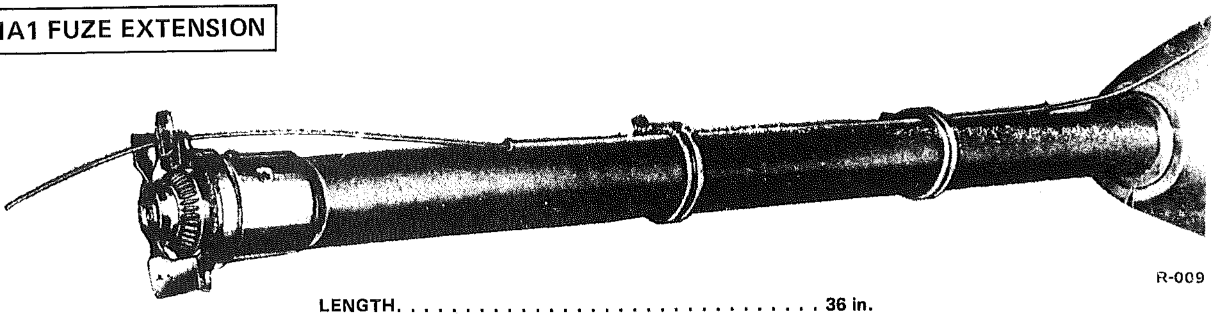
The MK 82 with M1A1 fuze extension (figure 1-30) is a standard bomb with a 36-inch long steel tube containing an M904 fuze attached to the nose. In this configuration, the bomb will impact the target area and detonate prior to being imbedded in the ground thereby providing a better fragmentation patters. The fuze extension tube consists of a burster support and burster assembly, is 2.37-inche in diameter and filled with cast tetrytol. The tube is threaded at each end for attachment to the bomb and reception of the fuze. Only the M904 fuze is authorized for use with the M1A1 fuze extension.

The arming condition of the bomb nose and tail fuzes is manually selected by the three-position bomb arm switch mounted in the armament panel. This switch controls the arming solenoids in the pylon rack and determines which arming wire swivel loop or loops will be released or retained with the pylon.

Operation of the fuze commences upon release when the arming wires are withdrawn from the fuzes, permitting the fuzes to arm. Upon impact with the target, one or both fuzes operate, igniting the explosive train, which relays and amplifies the blast, in order to detonate the bursting charge of the bomb. If either fuze (nose or tail) malfunctions, the other will cause detonation of the bomb.

The fin assembly is used to stabilize the bomb in flight and permits greater accuracy in bombing operation. The fin assembly must be mounted in the "X" configuration when the bomb is carried on the aircraft.

M1A1 FUZE EXTENSION



LENGTH	36 in.
DIAMETER	2.37 in.
FUZE	M904

Figure 1-30.

The MK 81 bomb uses the MK 81 fin; the MK 82 bomb uses the MK 82 fin. The fins are similar in shape but differ in size.

MATRA TYPE 50 kg AND SAMP TYPE 25 GP BOMBS

These bombs (figures 1-31 and 1-32) have a relatively thin case with an ogival nose, parallel side walls and a tapered aft section. Both nose and tail fuzes are used for a majority of operations. Approximately 50 percent of the complete weight of the round is made up of explosive filler of tolite. Two suspension lugs, 14 in. apart are screwed to the bomb. These bombs use the conical type fin assembly.

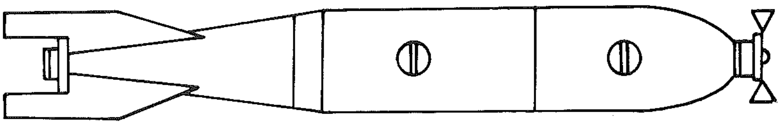
SAMP TYPE 25A HIGH DRAG GP BOMB

This bomb (figure 1-32) has the same shape and dimensions of the SAMP Type 25 bomb. A drag parachute housed in the tail cone deploys 0.3 s. after the bomb release by means of a timed device. The bomb fuzes remain in the SAFE position if the drag parachute does not deploy.

AN-M57A1, AN-M30A1, AN-M64A1 GP BOMBS - USAF OLD SERIES

These bombs (figures 1-33, 1-34 and 1-35) have a relatively thin case with an ogival nose and parallel side walls, on a tapered section. Both nose and tail fuzes are used for a majority of operations, approximately 50 percent of the complete weight of the round is its explosive filler that can be Amatol, TNT or Tritonal. Two suspension lugs 14 in apart are welded to one side of the bomb, a single lug is welded to the opposite side at the center or gravity.
The bombs can use either the box-type fin assembly or the conical type fin assembly.

MATRA TYPE 50 kg GP BOMB

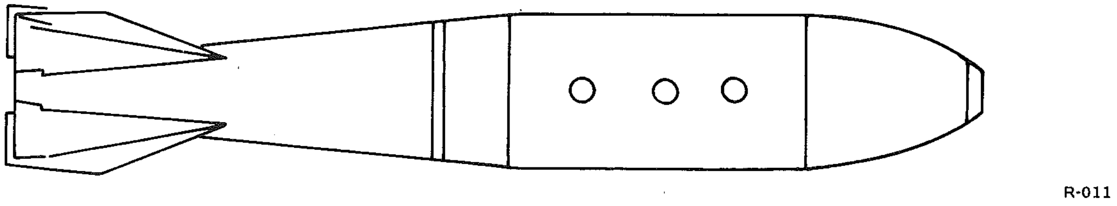


MASS (WITHOUT FUZES)	130.1 lb
LENGTH	55.5 in.
DIAMETER	7.08 in.
FIN SPAN	10.0 in.

FUZE (NOSE)	STA type 10A or STA type 11A or AN-M103A1
FUZE (TAIL)	LIP type 25 or AN-M102A2
MASS OF FILLER	48.5 lb

Figure 1-31.

SAMP TYPE 25 AND 25A GP BOMBS

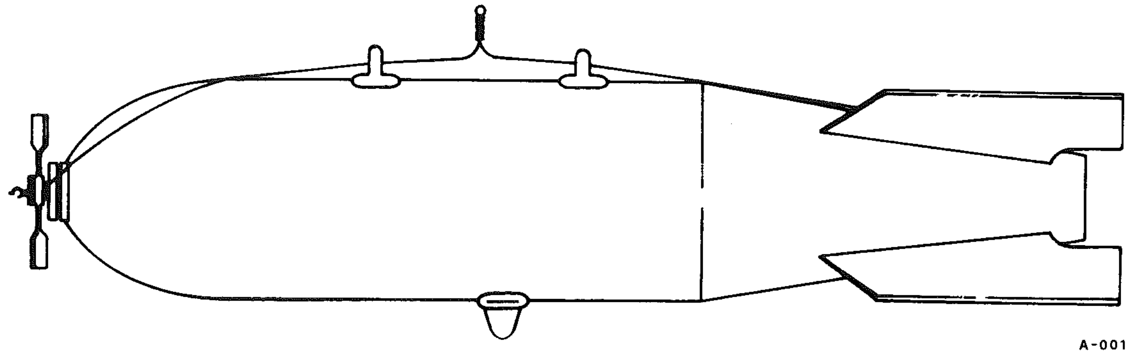


MASS	550 lb
LENGTH	82.52 in.
DIAMETER	12.65 in.
FIN SPAN	12.7 in.
MASS OF FILLER	247 lb

	Type 25	Type 25A
FUZE (NOSE)	STA 11A	MATRA 19
FUZE (TAIL)	EB28	MATRA 20

Figure 1-32.

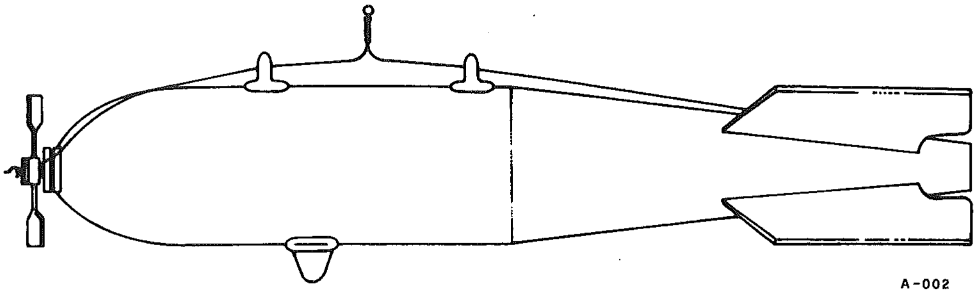
AN-M57A1, 250 lb, GP BOMB



MASS	273 to 289 lb
LENGTH	62.2 in.
DIAMETER	10.9 in.
FIN SPAN	15.0 in.
FUZE (NOSE)	STA Type 10 or 11A or AN-M103A1
FUZE (TAIL)	LIP Type 25A2 or AN-M100A2 or LIP 112F or M112
MASS OF FILLER	98.4 lb Amatol or 125.0 lb TNT or 136.0 lb Tritonal

Figure 1-33.

AN-M30A1, 100 lb, GP BOMB



MASS	128 to 136 lb
LENGTH	54.2 in.
DIAMETER	8.18 in.
FIN SPAN	11.8 in.

FUZE	See P.I. 11-1-1
MASS OF FILLER	54 lb Amatol or 57 lb TNT or 62 lb Tritonal

Figure 1-34.

Bombing tables are provided in Volume 2 for the conical type fin assembly only. GP bombs is to be released at IAS above 300 kt must be fitted with conical type fin assembly.

These bombs have the same shape, ballistic coefficient and design features.

MATRA SAMP TYPE 57, 250 lb ,GP BOMB

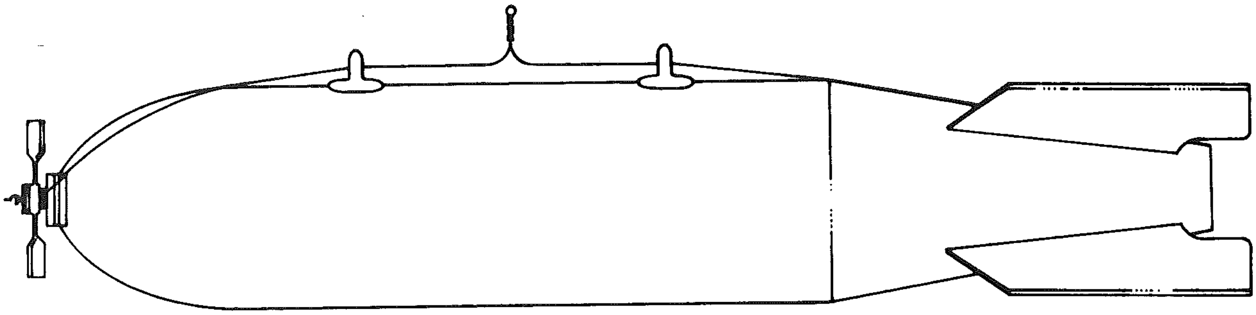
This bomb (figure 1-33) is identical in shape, mass and explosive filler to the AN-M57A1 GP bomb.

MATRA TYPE 81 OR AN-M81 FRAGMENTATION BOMB

This bomb (figure 1-36) is an anti-personnel 115 kg (260 lb). The cylindrical part of the bomb body is constructed of a spirally-wound wire. A seamless inner tube forms the base of the outer-wound one-inch square steel wire.

The bomb can be provided of a M103 box type fin or of a M235F conical type fin. When the bomb will be relased at a speed higher than 350 kt the M135F conical type

AN-M64A1,500 lb, GP BOMB

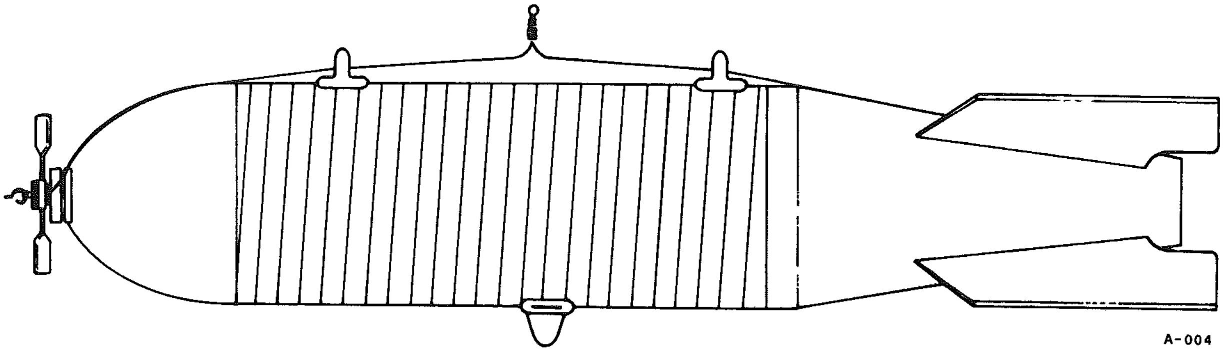


MASS	564 to 586 lb
LENGTH	72.10 lb
DIAMETER	14.18 in.
FIN SPAN	19.56 in.

FUZE	See P.I. 11-1-1
MASS OF FILLER	262 lb Amatol or 266 lb TNT or 273 lb Composition B or 283 lb Tritonal

Figure 1-35.

AN-M81, MATRA TYPE 81 AND AN-M88 BOMBS



AN-M81

MASS	260 lb
LENGTH	58 in.
DIAMETER	8.13 in.
FIN SPAN	11.02 in.
FUZE (NOSE)	STA type 10, or 11A, or AN-M103A1
FUZE (TAIL)	LIP 25A2, or AN-M100A2

Other fuzes are listed in T.O. 11-1-28

MASS OF FILLER	37 pound tolite hexogene 60/40

AN-M88

MASS	217.7 lb
LENGTH (conical fin)	58.0 in.
DIAMETER	8.12 in.
FIN SPAN	11.19 in.
FUZE (NOSE)	M904E1 or AN-M1A2 or M14 or MK1 or AN-M6A2
FUZE (TAIL)	MK1 or AN-M6A2 or AN-M1A2 or M14 or M162 or AN-M175

Other fuzes are listed in T.O. 11-1-28.

Figure 1-36.

fin must be used. Three suspension lugs are welded to the bomb: two lugs 14 in. apart for standard MA-4A rack suspension and a lug for a single-point suspension at the center of gravity of the bomb.

AN-M88 FRAGMENTATION BOMB

The AN-M88 220 lb fragmentation bomb (figure 1-36) has a body constructed of spirally-wound 3/16 inch-square steel wire over a seamless steel tube which forms the base for the wrapping. Solid nose and tail for-gings complete the bomb assembly. The nose and tail sections are threaded to accomodate nose and tail fuze.
A fin assembly AN-M103A1, box type, or a conical fin assembly M135 can be secured to the aft end of the bomb. The conical fin only must be used for release airspeed higher than 350 kt.

AEREA 559G1, 500 lb, FIRE BOMB

This bomb (figure 1-37) is a fire bomb built in syntetic resin bonded laminate and is made in two symmetric halves lon-gitudinally couples, with the advantage of obtaining, when disassembled, the minimum storage space (about six time less than the other containers having the same capacity).
The type 559G1 fire bomb has the same plastic body of the pylon fuel tank, 260 litres, AEREA Part No. 530RG2. In lieu of the filler caps the bomb carries two igniters Part No. 64057 and, obviously, no internal plumbing is installed. Suspension lugs are standard 14 in.

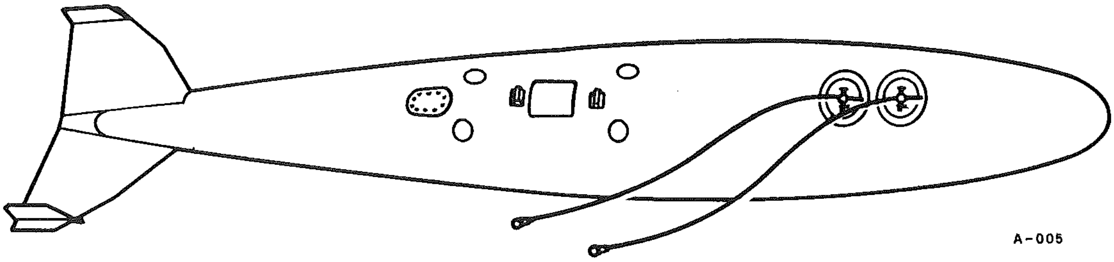
WARNING

This bomb must not be loaded on station 3 and 4 because of interference with wing flaps in T/O and in DOWN position.

CAUTION

This bomb does not meet the minimum ground clearance requirements and requires extreme caution during landing with unexpended bombs.

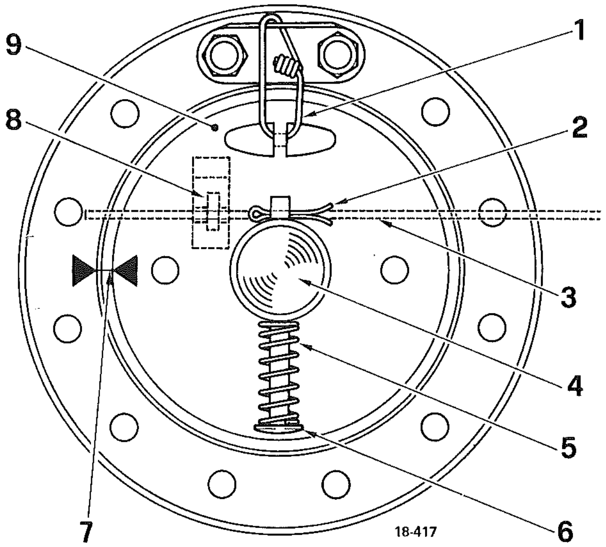
AEREA TYPE 559/G1 FIRE BOMB



MASS, FULL	253 kg (557 lb)
MASS,EMPTY	45 kg (99 lb)
NAPALM CAPACITY	68.5 US gals (260 litres)
LENGTH	3280 mm (129.4 in.)
DIAMETER	430 mm (17 in.)
FIN SPAN	750 mm (29.5 in.)
FUZES	2 AREA Igniters Ref. No. 64057

Figure 1-37.

AEREA 64057 FIRE BOMB IGNITER



1. FIRING CHARGE SAFETY WIRE (0.8 mm dia)
2. GROUND SAFETY COTTER PIN (REMOVE BEFORE FLIGHT)
3. ARMING WIRE
4. IGNITER
5. SPRING
6. SAFETY PIN
7. REFERENCE MARKINGS (MUST BE ALIGNED)
8. FAHNESTOCK CLIP
9. BODY

Figure 1-38.

ROCKETS, ROCKET LAUNCHER, HEADS AND FUZES

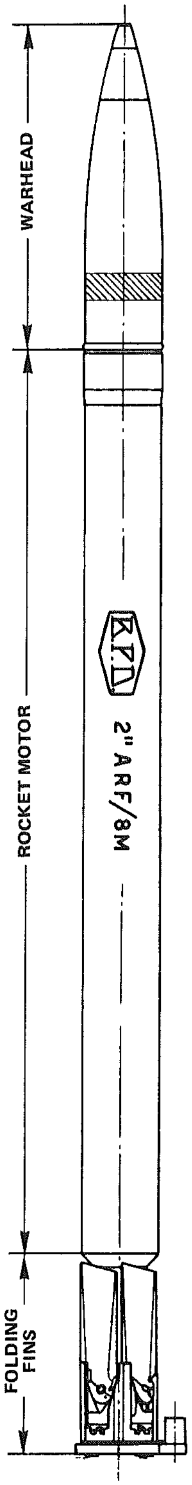
50 mm ARF/8M2 ROCKET

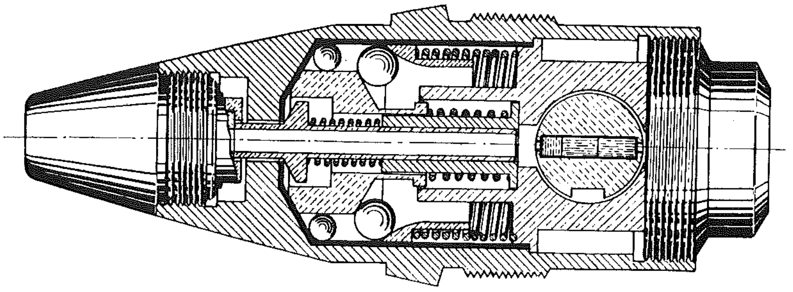
The SNIA-BPD type 50 mm ARF/8M2 (nominal caliber 2 in.) rocket is designed to provide air-to-ground armament for tactical aircraft (fig. 1-39). The rocket has a special free rotating fin assembly composed of four blades folding within the outside diameter. The rocket motor has a single ejection nozzle and a single grain propellant which is pratically unaffected by temperature variations and burns out in an average time of 1.15 sec giving a considerable initial acceleration to the rocket.
The ARF/8M2 rocket can be configurated with various rocket heads and fuzes as follows:

a. Heads
  - Inert
  - High explosive incendiary (HEI)
  - Heavy weight HEI
  - Armour piercing incendiary (API)
  - Fragmentation

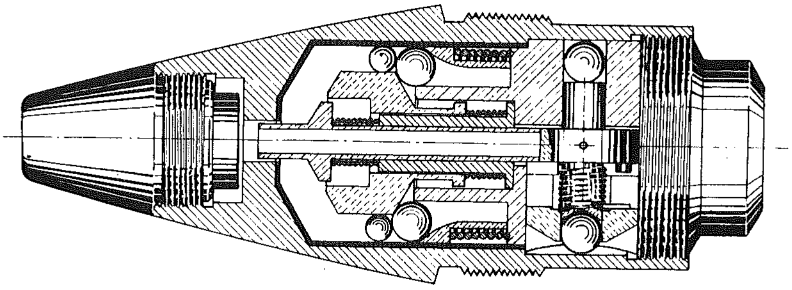
b. Fuzes
  - Dummy
  - Point detonating, average sensitivity
  - Piezoelectric, base detonating

SNIA-BPD 50 mm ARF/8M2 ROCKETS

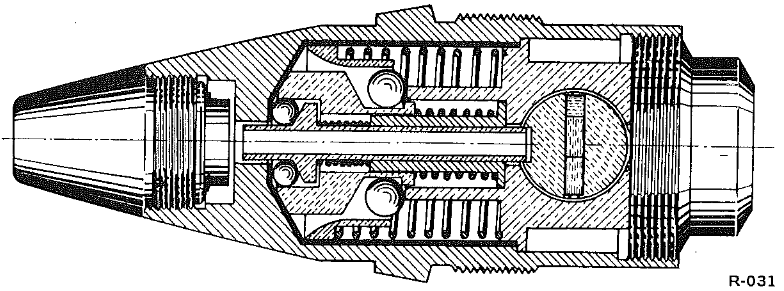




POINT DETONATING FUZE
IN SAFETY POSITION



POINT DETONATING FUZE
IN PRE-ARMING POSITION



POINT DETONATING FUZE
IN ARMING POSITION

MASS, with HEI warhead	3.6 kg (7.9 lb)
MASS, with API warhead	3.8 kg (8.4 lb)
DIAMETER (NOMINAL)	50 mm
LENGTH, with HEI warhead	927 mm
LENGTH, with API warhead	1002 mm
COMBUSTION TIME, at 21 °C	1.1 s

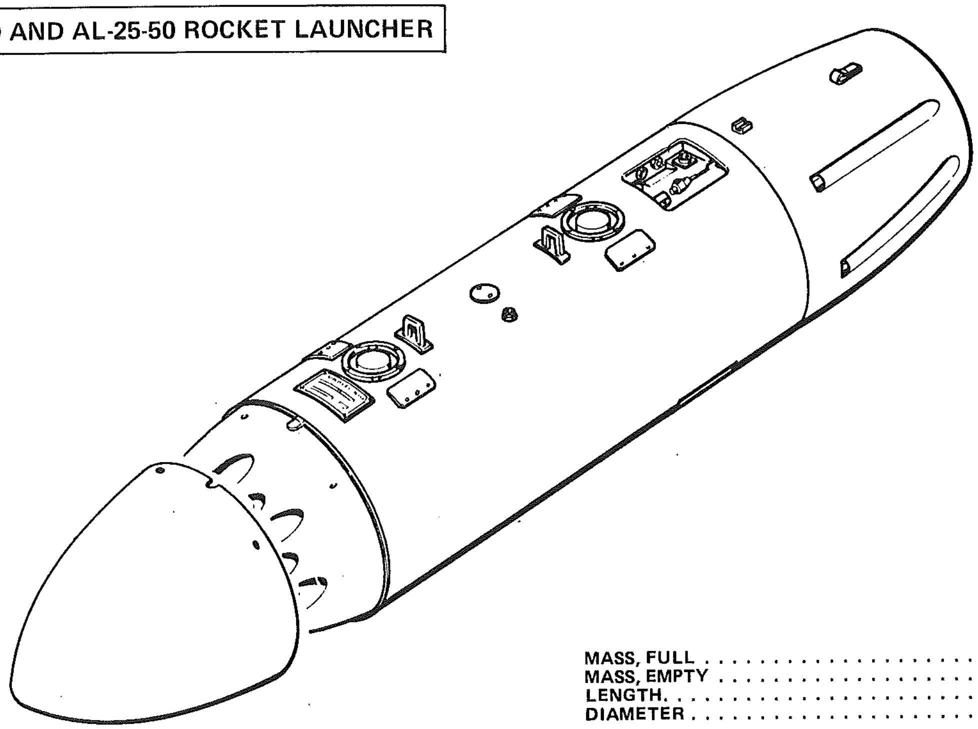
Figure 1-39.

AEREA TYPE LR-25-0 OR AL-25-50 ROCKET LAUNCHER

The LR-25-0 "ORIONE" or AL-25-50 rocket launcher (fig. 1-40) carries and launches twentyfive 50 mm folding fin aircraft rockets. A loaded launcher configuration consists of a loaded center section body and a nose bonded and riveted to the body. The rocket launcher body is formed by a fiberglass shell, in the inside of the shell are riveted three flanges, connected between them by four tie rods that provide the support for the 25 launch tubes.

In the lower sides of the control body is housed the intervalometer, accessible through an access door, Aster, Part No. 3067/A that is of reusable type, with the possibility to fire up to 30 rockets with a fire cadence of 1/30 of second and with a sequence as follows: single, 5 rockets, 25 rockets (the last five pulses are not used by this launcher). The sequence control switch 1-5-25 can be adjusted before flight and is located, together with the supply and test connectors, in a box installed in the back of the control body.
This launcher can fire 25 rockets SNIA-BPD, 50 mm type ARF/8M2.

LR-25-O AND AL-25-50 ROCKET LAUNCHER



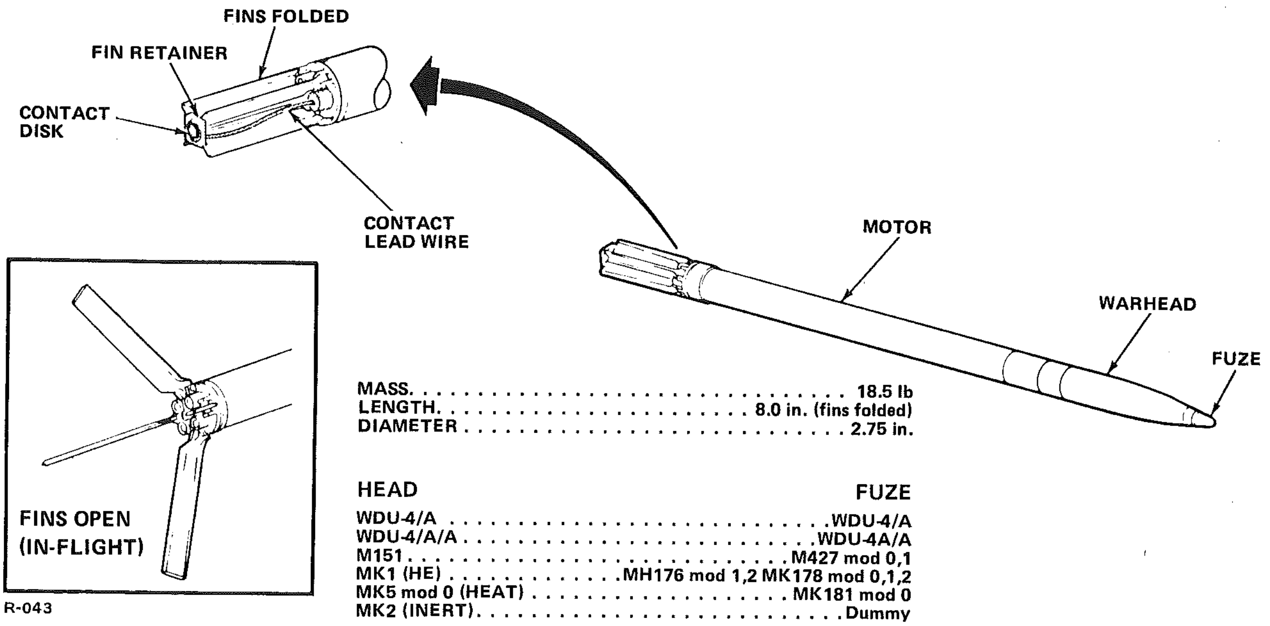
MASS, FULL	342 lb
MASS, EMPTY	110 lb
LENGTH	78.74 in.
DIAMETER	15.43 in.

Figure 1-40.

FFAR, 2.75 in. ROCKET

The 2.75 in. folding fin aircraft rocket (FFAR) (figure 1-41) is designed to provide air-to-ground armament for tactical aircraft. The rocket can be configured with various rocket heads (warheads) and fuze (figure 1-42) to accommodate the tactical requirements: high-explosive (HE), antitank (HEAT), fragmentation (pearlite malleable iron (PMI), flechette (steel darts), or a plasterloaded inert head used for pratice. The rockets are fired from the LAU-3/A, LAU-32A/A, LAU-32B/A launchers. The rocket motor tube is made of seamless aluminium alloy tubin and is 32 in. long. The rocket motors are designated MK4 Mods 0 through 8. The propellant used is an internal burning grain ballistite. The burning rate of the propellant varies with temperature, from 2.92 s. at -50°F to 1.42 s. at 130°F. The propellant grain in rocket mo-

2.75 in. FOLDING FIN AIRCRAFT ROCKETS (FFAR)



MASS	18.5 lb
LENGTH	8.0 in. (fins folded)
DIAMETER	2.75 in.

HEAD	FUZE
WDU-4/A	WDU-4/A
WDU-4/A/A	WDU-4A/A
M151	M427 mod 0,1
MK1 (HE)	MH176 mod 1,2 MK178 mod 0,1,2
MK5 mod 0 (HEAT)	MK181 mod 0
MK2 (INERT)	Dummy

Figure 1-41.

tors MK4 Mods 0, 2 and 3 is sensitive to temperature change. The propellant grain used in rocket motors MK4, 5, 6, 7 and 8 is relatively insensitive to temperature change. The rocket motor is ignited by aircraft electrical power through an igniter. An electric squib ignites the mixture of black powder and magnesium powder contained in the ignitier. The igniter is located at the forward end of the rocket motor in the head closure of the motor assembly. The rocket nozzle fin assembly, which attaches to the rear end of the motor tube, basically consists of a nozzle plate, four nozzles, a fin actuating mechanism, four folding fins, and a fin retainer and contact disc. Gas pressure from the motor operates the piston and cross head, pushing the heels of the fins and, thereby, causing the fins to open.

The cross head remains in its rearmost position and is effective in locking the extended fins in their normal angular projection, rearward against the force exerted by the airstream, even after loss of internal pressure at motor burnout. The fins are shaped aluminum alloy plates, 6.5-inch long by 1.26-inch wide. When folded, they extend to the rear within the 2.75 in. diameter of the round.

MK176 Fuze (PD)

The MK176 fuze is a cone-shaped, steel--constructed, point-detonating, delay nose fuze. The fuze is detonator-safe and is armed when the sustained acceleration of the rocket motor overcomes the force of the anti-setback springs that restrain the weight of the fuze arming mechanism. The rate of acceleration required for arming is approximately 20 g which insures that the rocket will travel at least 500 ft before the fuze will arm. The maximum distance allowed for arming is approximately 1400 ft. The fuze contains the firing mechanism, arming mechanism, primer, delay element, detonator, lead and booster. The delay element provides a 0.0003 second delay. The fuze is threaded at the lower end for attachment to the HE or PMI warheads.

MK178 Fuze (PD)

MK178 fuze is similar to the MK176 fuze, except that the delay element, between the primer and the detonator, has been removed and replaced by a flash tube, to reduce fuze function time. The production model is designated Mod. 2.

MK181 Fuze (Point Initiating - Base Detonating)

The MK181 fuze is used exclusively with the HEAT warhead (shaped-charge). The MK181 fuze contains a shaped-charge booster, which directs a jet of hot gas rearward to the base of the HEAT warhead, to initiate the booster pellet, which, in turn, initiates the main charge of the HEAT warhead. Upon impact, the shaped-charge booster is initiated. The booster is concaved at the base to direct a jet stream through the apex of the HEAD shaped-charge and flash tube to ingite the booster pellet located at the base of the warhead. The booster pellet, in turn, initiates the HEAT shaped--charge to produce a greater jet stream in the opposite direction. This design achieves faster fuze functioning, thereby increasing overall efficiency of the shaped-charge HEAT head. The arming mechanism of the MK181 base-detonating fuze is similar to MK176/178 fuze arming mechanism. The fuze is detonator-safe and is armed by sustained acceleration of approximately 20 g. This insures that the rocket will travel at least 400 ft before the fuzes arm. The maximum distance for arming is approximately 1400 ft.

M423 and M427 Fuze (Superquick)

The M423 and M427 fuzes are modifications of the MK178 fuze to provide a superquick, graze sensitive fuze that will provide warhead detonation above ground to increase the fragmentation produced by the M151 warhead. The fuze is also used with the white phosphorus filled M156 warhead. The difference between the M423 and M427 fuze is that the M423 has a shorter arming time than the M427 fuze. The fuze is detonator-safe, employing a detonator-out-of-line rotor that is brought into alignment by the G forces of rocket motor acceleration.

The detonator-safe mechansim, installed in the fuze, is basically the same as that installed on the MK176/178, requiring 20 g for approximately one second to complete the arming sequence. This provides a minimum of 500 ft to a maximum of 1200 ft, of safe travel before the warhead is armed. The fuze will function instantaneously without ricocheting off hard ground or burying in a soft mud or water. The base of the fuze contains a striker plate, which centers an auxiliary striker pin over the firing pin. The striker plate transmits any rearward vector force to the firing pin to assure reliable functioning at low impact angles.

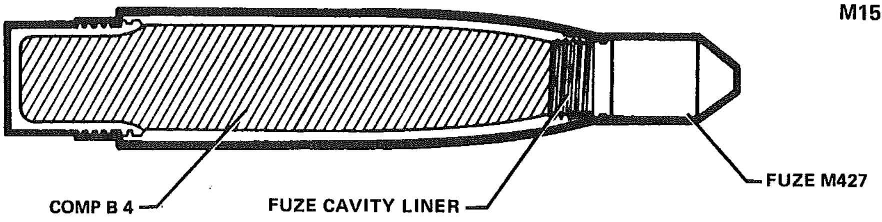
WDU-4/A and WDU-4A/A Fuze

The WDU-4/4 fuze is used with the WDU-4/A warhead (flechette). The WDU-4A/A fuze is used with the WDU-4A/A warhead (flechette). The fuze section contains the same safe and arming mechanism as the MK176 fuze, with the addition of a metal dowel that is press fitted into the rotor. The pin prevents a spring-loaded setback piston from moving forward and releasing the spring-loaded firing pin. The firing pin is held in place by a steel locking ball which rests in the groove of the firing pin. The ball, in turn, is held in place by a steel spacer pin, which rests against the spring-loaded setback piston. This acceleration-activated arming mechanism provides a minimum of 500 ft aircraft separation before the fuze arms. When the rocket is fired, the acceleration force compresses the spring of the setback piston, moving it to the rear. This action allows the rotor to move the dowel pin aft, and line up the ignition train in the rotor, with the firing pin. As the rocket acceleration decreases, just prior to rocket motor burnout, the spring pushes the setback piston forward, releasing the pin and ball that holds the firing pin. The spring-loaded firing pin pushes the retaining ball out of the groove and fires the expulsion charge. In the expansion chamber, the expulsion charge developes a gas pressure of approximately 1300 psi and forces the pusher plate, flechettes, and hemicylindrical sleeves forward, shearing the pins that hold the nose plate. As the pusher plate moves forward, the flechettes and sleeves are pushed out of the main body cylinder and expelled into the slip stream ahead of the rocket. The hemicylindrical sleeves keep the flechettes from dispersing until all have been forced out of the main body cylinder.

MK1 Warhead (HE)

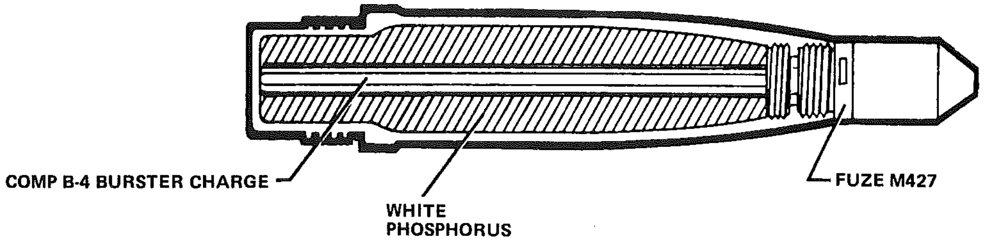
The MK1 (HE) high explosive rocket warhead is 11.1 inches in length and weights 6.47 lb, with the MK178 point detonating fuze or MK176 fuze installed. The warhead is loaded with 1.4 lb of HBX-1 high explosive for blast, fragmentation, mining or demolition effects. When the HE head is used as an air-to-air weapon, the MK176 fuze is employed. When the HE head is used as an air-to-ground weapon, the warhead should be configured with the faster functioning MK178, M423 or M427 fuzes. The MK178 fuze would allow the warhead to penetrate for internal blast and mining, whereas the M423 or M427 fuze would provide a surface

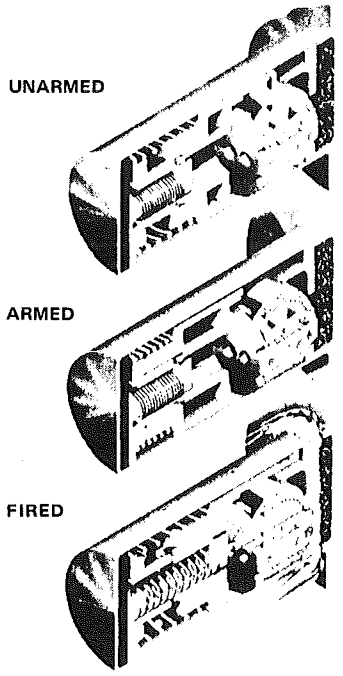
FFAR WARHEADS AND FUZES



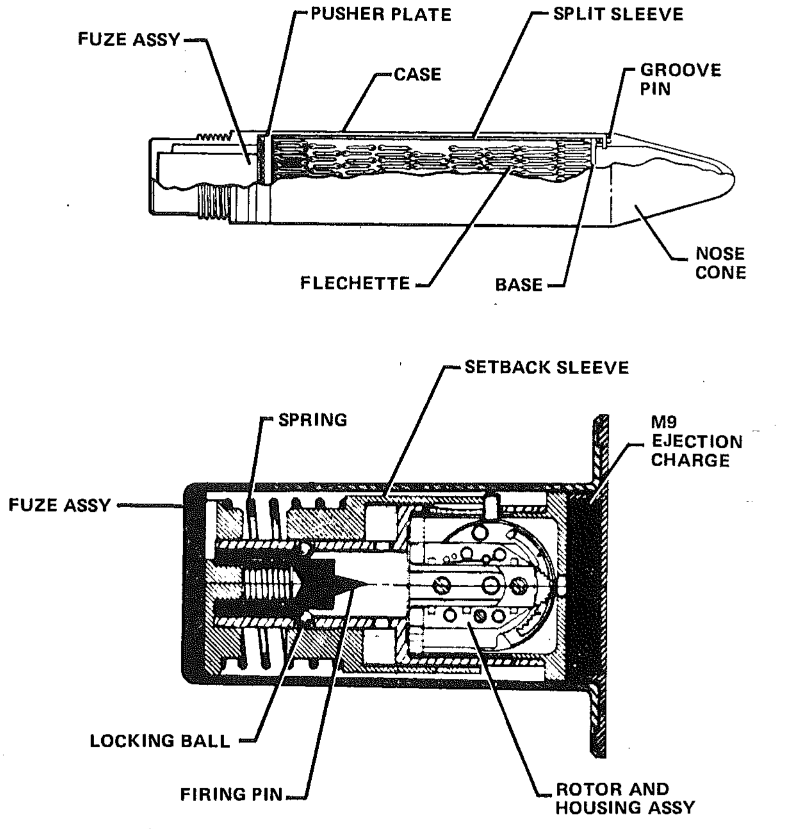
M151 WARHEAD (MP1) AND M427 FUZE

M151 WARHEAD (WP) (WHITE PHOSPHORUS) AND M427 FUZE





WDU-4/A AND WDU-4A/A FUZE OPERATIONAL SEQUENCE



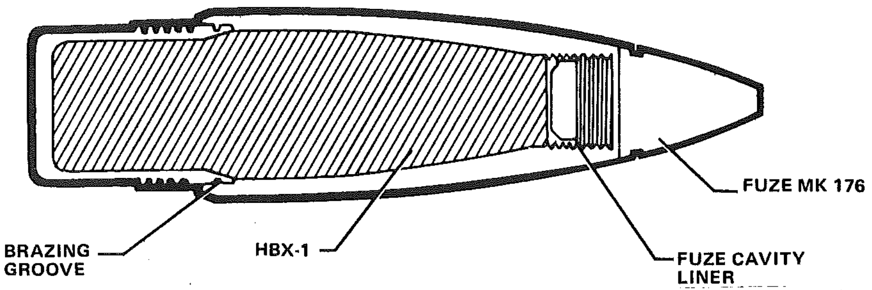
WDU-4/A AND WDU-4A/A WARHEAD (FLECHETTE) AND FUZE

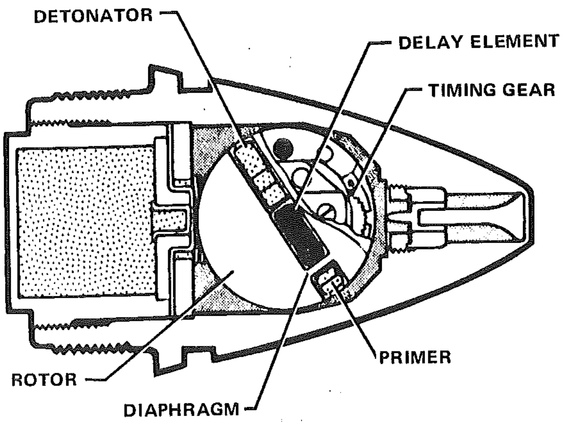
R-012

Figure 1-42. (Sheet 1)

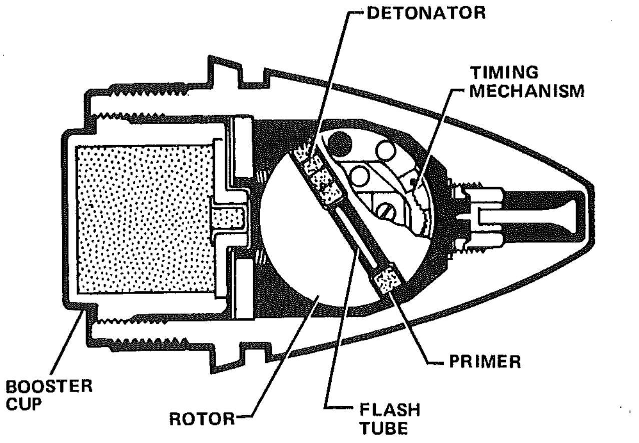
FFAR WARHEADS AND FUZES

MK 1 WARHEAD (HE)

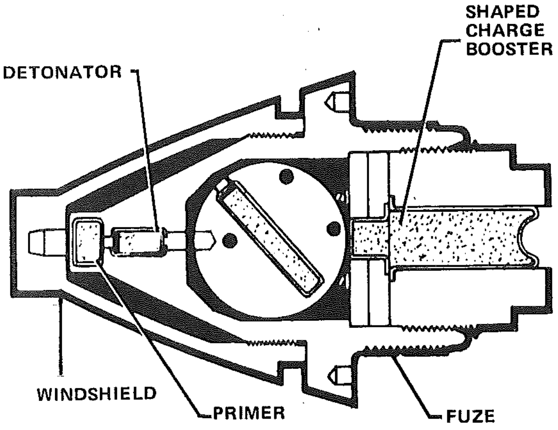




MK 176 FUZE (PD)



MK 178 FUZE (PD)



MK 5 WARHEAD (HEAT) AND MK 181 FUZE
(POINT INITIATING-BASE DETONATING)

2.75 COMPONENTS	
2.75 in. ROCKET MOTOR MK4 MODS 0 THRU 8	
FUZE	WARHEAD
WDU-4/A	WDU-4/A (FLECHETTE)
WDU-4A/A	WDU-4A/A (FLECHETTE)
M427 MODS 0,1	M151 (PM1 OR WP)
MK176 MODS 1,2	MK1 MODS 1,3,4,5
MK178 MODS, 0, 1, 2	
MK181 MOD 0	MK5 MOD 0 (HEAT)

SHAPED CHARGE WARHEAD

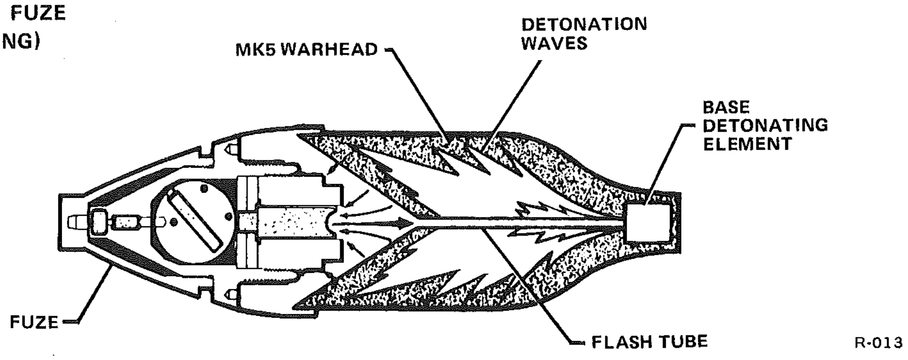


Figure 1-42. (Sheet 2)

burst, thereby increasing fragmentation effects. The inert warhead has the same configuration and carries an inert load of plaster and a dummy fuze.

MK5 Warhead (HEAT)

The MK5 (HEAT) warhead has the same dimensions and weight as the HE warhead. All models of the HEAT warhead are designated MK5. The MK5 warhead is constructed with a shaped charge for penetration of armored wehicles, tanks, and other resistant targets. The length and weight of the HEAT head, with the MK181 base detonating fuze installed, is the same as the HE head. The HEAT head is loaded with 0.89 lb of composition B, with a shaped charge for penetration of armored or other resistant targets. The shaped charge is designed to focus all the energy of the detonation into a narrow, high velocity jet. On impact, the detonator, located at the base of the fuze, is ignited to detonate the explosive charge. The shock waves of the detonation move forward from the base toward the apex of the thin metal liner that forms the concaved cone at the front of the shaped charge. The strong outer shell of the shaped charge is not shattered by the detonarion. Collapse of the thin metal starts at the apex of the cone. As the liner collapses, it ejects a narrow jet of explosive products and metal particles at extremely high velocities. The jet is first to strike the target, followed by the main body of the cone, referred to as the secondary penetration or the slug. When the jet strikes the target, pressures up to 250 000 psi are produced at the point of impact. The depth of jet penetration is a function of the target density rather than strength. There is no appreciable lateral blast effect or temperature rise produced by the shaped charge, since all the energy is directed forward.

MK151 Warhead (PMI)

The M151 (PMI) warhead has a pearlite, malleable iron case designated to produce high fragmentation. The warhead is employed as an air-to-ground, anti-personnel and anti-material weapon. The warhead is 2.75--inche in diameter, approximately 15-inche in length, and weights 4.9 lb with the M423 or M427 superquick fuze installed. The warhead is loaded with 2.37 pounds of Comp B-4 explosive for fragmentation and blast effect. The superquick fuze, greater length of warhead, and improved fragmentation breakup of the PMI case combine to provide more than twice the effectiveness of the standard HE warhead.

M156 Warhead (WP)

The M156 (WP) warhead, filled with 2.13 lb of white phosporus (WP), has the same external shape as the M151 (PMI) warhead. The M156 is used for target spotting. A bursting tube containing three ounces of Comp B-4 is inserted through the center axis of the warhead. The explosive tube is detonated upon impact by the M423 or M427 fuze, to cause dispersion of the white phosphorus. White phosphorus (WP) is a yellow, wax-like substance that melts at 111°F. The most characteristic property of WP is sponstaneous ignition when exposed to air, burning with a yellow flame and giving off a large volume of white smoke. The smoke, in field concentrations, is not toxic; however, the fumes are toxic.

WARNING

If the white smoke is detected arising from a leaking warhead, there is an immediate danger of fire.

WDU-1/A and WDU-4A/A Warhead (Flechette)

The WDU4 warhead is a flechette (miniature steel dart) ejection warhead, providing a considerable increase in anti-personnel effectiveness over other rocket warheads. The WDU-4 warhead is 2.75-inch in diameter, 17.76-inch long, weights 9.4 lb and contains a base fuze, ejecting charge, piston, 6000-8 grain flechettes (WDU-4/A) or 2200-20 grain flechettes (WDU-4A/A), and an aerodynamic nose cone. The WDU-4 warhead is compatible with all 2.75 in. FFAR motors and launchers. The fuze is installed during assembly and is an integral part of the warhead. At launch, acceleration forces arm the fuze. A motor burnout (approximately 1.8 s after launch), an airburst is initiated by the deceleration forces, which frees the spring-loaded firing pin to ignite the M9 ejecting charge. The M9 ejecting charge generates a gas pressure against the pusher plate (piston) which transmits the pressure through the stacked flechettes and to the shear pins on the nose cone. The shear pins are broken, to allow the nose cone to be ejected, and are followed by the flechettes. The flechettes are packed tightly in the split sleeves with alternating flechettes pointing fore and aft. When the flechettes are ejected, aerodynamic forces cause the tail-forward flechettes to tumble and streamline; this weathervaning causes dispersion. Slant range at launch is a factor in determining the slant range at rocket motor burbout, therefore, it is a critical factor in determining the dispersion and weapon effectiveness. Refer to the rocket launch table for flechette warhead ballistics data, Volume 2.

Rocket Motor Assembly

The rocket motor tube is made of seamless aluminum alloy tubing and is 32 in. long. The propellant used is an internal burning grain ballistite. The external surface of the grain is covered to prevent the grain from burning on the outside. The burning rate of the propellant varies with temperature, from 2.92 s at -50°F to 1.42 s at 130°F. The rocket motor is ignited by aircraft electrical power through an igniter. An electric squib ignites the mixture of black powder and magnesium powder in the igniter.

Rocket Nozzle/Fin Assembly

The rocket nozzle/fin assembly, attached to the aft end of the motor tube, basically consists of a nozzle plate, four folding fins, and a fin retainer and contact disc.
Gas pressure from the motor operates the piston and crosshead, pushing the heels of the fins and causing the fins to open. The crosshead remains in its rearmost position and is effective in locking the extend fins in their normal angular projection, rearward against the force exerted by the airstream, even after loss of external pressure at motor burnout. The fins are shaped aluminum alloy plates 6.5-inch long and 1.25-inch wide. When folded, they extend to the rear within the 2.75 in. diameter of the round. The forward end corners are cutout and doubled so that the fins will clear the nozzles when closed and clear the exhaust blast when open.

FFAR ROCKET OPERATION

The rocket firing sequence is determined by an intervalometer comprised in each container. The rocket containers are attached to the pylons through the pylon rack and are laterally stabilized by the sway braces. Firing of the FFAR rockets is possible only on condition that the landing gear control lever is set at UP. On the ground, the circuit can be tested by moving the "GROUND FIRE" switch to ON and holding it there. The FFAR rocket circuit is powered from the secondary bus bar. Arming of the FFAR rocket circuit for operation is made by moving the "FWD ARMT" selector switch to FFAR and pressing the arming push-buttons corresponding to the container of the rockets that it is desired to fire. This action energizes the arming push-button retaining solenoid. Subsequently, the forward armament safety switch will be moved to ARMT & CAM. This latter operation will bring on the lights incorporated in the previously depressed arming push-buttons. The number or rockets to be fired in each salvo is selected through the "SEQUENCE" switch. With this switch in the SINGLE position, a single rocket is fired from each selected rocket container whenever the firing tigger switch is depressed; in the AUTO or FOUR position the rockets will fire continuosly from the selected containers until the firing trigger switch is released. This is due to a relay which provides a second power supply for the container during the firing of a burst of rockets. In case a single rocket is fired, the second power supply to the container is interrupted by the same relay.

NOTE

Not all tubes of rocket container incorporate provisions for in-flight selection of the number of rockets to be fired. On many types this selection must be made on the ground by means of a special switch comprised in the rocket container.

Pulling the firing trigger switch energizes the rocket container through. The rockets will thus be fired in the sequence determined by the rocket container intervalometer and in the number pre-set through the "SEQUENCE" switch.

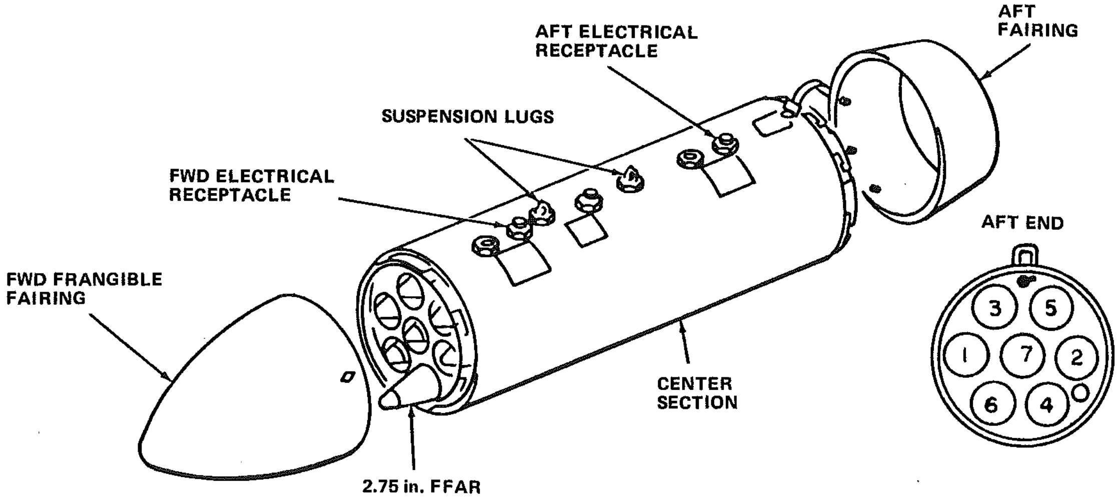
WARNING

When more than two rocket launchers are carried, simultaneous firing action is allowed only by two simmetrical launchers at a time.

LAU-68/A ROCKET LAUNCHER

The LAU-68/A rocket launcher is a reusable launcher, firing seven 2.75 in. FFAR (fig. 1-43). The launcher has a selective single

LAU-68/A ROCKET LAUNCHER



R-039A

MASS, EMPTY	.71 lb
MASS, LOADED (19 ROCKETS)	.191 lb
LENGTH	94.5 in.
DIAMETER	15.75 in.

Figure 1-43.

or ripple fire intervalometer, which is removable. The launcher also has provisions for grounding all firing circuits.

The suspension system is compatible with bomb racks that incorporate a 14 in. suspension. The forward and aft fairings fit flush the outside surface of the center section to form an aerodinamically smooth joint with a locking band for attachment to the launcher center section.

The forward fairing consists of a one-piece impregnated molded fibre section which disintegrates on rocket impact.

WARNING

Use of forward fairing set is forbidden on MB-326K( ) aircraft.

The reusable aft fairing is a one-piece unit assembly (aluminum) which remains on the launcher to act as a choke or funnel to direct debris away from the aircraft. The aft fairing can be reused at least six times.

A reusable intervalometer (step-type) and a single-ripple selection switch are set at the aft end of the launcher.

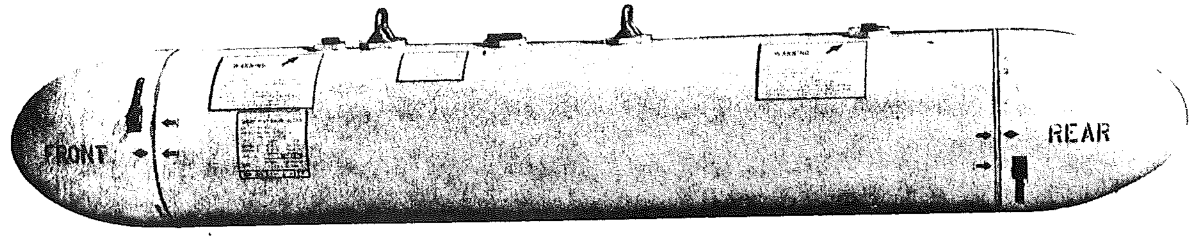
A shorting pin is located on the center section of the launcher. When the shorting pin is inserted in the receptacle, the input circuit is opened and the internal circuit is grounded.

Detent devices within the tubes restrain the rockets against normal flight loads.

LAU-32B/A, LAU-32G ROCKET LAUNCHER

The LAU-32B/A and LAU-32G (European version of LAU-32B/A) are seven tube, 2.75 in. rocket launchers (figure 1-44). The LAU-32U/A is a reusable type rocket launcher having metal tube construction and a resuable 20 ms delay intervalometer. The launcher consists of three major components: a center section, and rear section, both of which may be used on repeated firings, and forward frangible fairing that shatters on rocket firing. The center section contains the suspension system, all electrical circuits, metal launching tubes with detens, and the intervalometer. Detent de-

LAU-32B/A ROCKET LAUNCHER



MASS, EMPTY	272 kg
MASS, LOADED (7 ROCKETS)	83 kg
LENGTH	1.580 mm
DIAMETER	245 mm

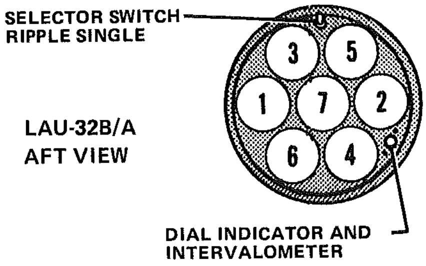


Figure 1-44.

vices, within the tubes, restrain the rockets against normal flight loads, and provide electrical contacts to the rockets. Contacts on the launcher aft bulkhead provide the rocket with a ground so that the firing circuits may be energized. Two receptacles, on top of the center section, provide for connection to the aircraft rocket firing circuitry, only one of which will be connected to the aircraft, as they are wired in parallel. As a safety requirement on the launchers, the receptacle that is not connected to the aircraft is fitted with a shorting button, attached to the receptacle dust cover, that grounds the launcher armament circuit, preventing inadvertent operation of the intervalometer.

AEREA AL-18-50 ROCKET LAUNCHER

The AL-18-50 rocket launcher (fig. 1-45) carries and launches 18 folding fin, 2 in. aircraft rockets. As the AL-25-50 launcher it consists of a loaded center section body and a nose bonded and riveted to the body. The body is formed by a fiberglass shell, in the inside of the shell three flanges provide the support for the 18 launch tube. An intervalometer, auto resetting electronic, is provided to fire the rockets at 1/30 second interval in single, pair, six, and ripple sequence.

An expendable nose fairing with 18 frangible diaphragms is provided. The tail fairing is of the reusable type.

The adapter cable Ref. No. 11L1-014-01A is necessary for the launcher installation on the Macchi standard pylon Ref. No. GB900-20-36 or GB900-20-11.

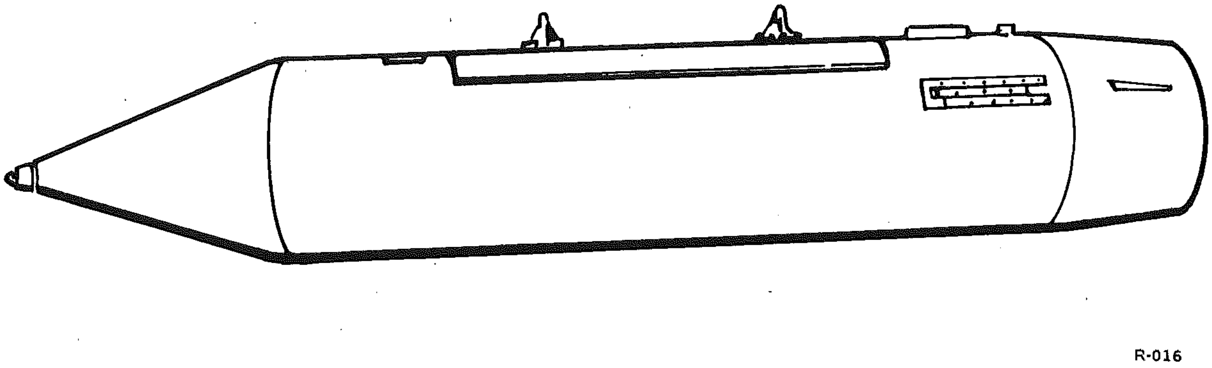
LAU-10/A ROCKET LAUNCHER

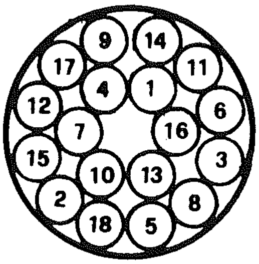
The LAU-10/A rocket launcher (fig. 1-46) carries and launches four 5 in. ZUNI FFAR (Folding Fin Aircraft Rockets).

WARNING

- This launcher must not be carried on station 3 and 4 because of interference with wing flaps in T.O. and DOWN position.
- This launcher does not meet the minimum ground clearance requirements and requires extreme caution during landing particularly with unexpended rockets.

AEREA AL-18-50 ROCKET LAUNCHER

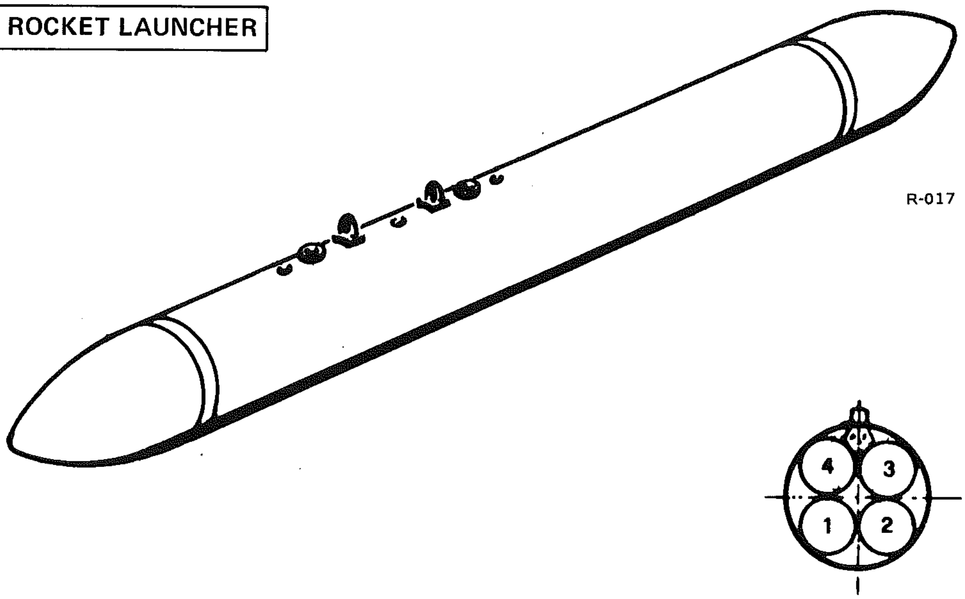




MASS, EMPTY	30 kg (66 lb)
MASS, FULL	99 kg (218 lb)
LENGTH	1740 mm (68.5 in.)
DIAMETER	305 mm (12 in.)

Figure 1-45.

LAU-10/A ROCKET LAUNCHER



MASS, EMPTY	48 kg (106 lb)
MASS, FULL	201 kg (445 lb)
DIAMETER	353 mm (13.9 in.)
TOTAL LENGTH	3545 mm (139.56 in.)
CENTRAL SECTION LEGNTH	2312 mm (91.0 in.)

Figure 1-46.

The launcher body consist of a center section which carries four loading tubes and contains the suspension system (2 lugs, 14 in. apart), all electrical circuits and the intervalometer, and two frangible fairings that can be installed or not for fight. In combat configuration, the launcher is closed at both ends by the fairings. A metal band at the fairing base, equipped with attaching lugs, joins the fairings to the center section. The fairings fit flush with the outside surface of the center launcher and form an aerodynamically smooth surface. The fairings shatter when the rocket is fired.

WARNING

> Use of forward fairing set is fordibben on MB-326K( ) aircraft.

The LAU-10/A rocket launcher, when installed on the Aermacchi pylon GB900-20-36 or GB900-20-11 requires the adapter cable 11L1-024-01 or 11L1-024-02 (connector MS3102-14S-5P). The rockets may be fired by single or ripple at 95 ms firing interval.

5.0 in. FFAR ZUNI ROCKET

The ZUNI rocket (fig. 1-47) is a supersonic unguided rocket designed for air-to-ground attack. The rocket uses the 5.0 in. MK16 rocket motor. The rocket is shipped stored in, and launched from, the four-round LAU-10/A or LAU-10A/A launcher container. The rocket motor consists of an aluminum alloy motor tube, a nozzle and fin assembly, a double base MK49 Mod 1 propellant grain, and an integral MK130 Mod 1 igniter. The nozzle and fin assembly is equipped with a fin retainer which holds the fins folded until the rocket is launched. Electrical contact to the launcher is made on the forward end of the rocket motor. The motor can be equipped with the MK24 or MK32 warhead. When the electrical firing impulse is applied to the rocket, the motor function as follows:

a. The two igniter squibs ignite and, in turn, ignite the igniter main charge.

b. Gas pressure, resulting from the burning igniter charge, ruptures the igniter case and projects flaming particles onto the propellant grain of the motor.

c. The propellant grain ignites.

d. Gas pressure, resulting from the burning propellant blows away the nozzle seal and fin retainer.

f. When the rocket leaves the launcher, the blast from the nozzle extends the folded fins and the fins lock in the opened position.

MK24 Mod 0 Rocket High Explosive Warhead

The warhead (fig. 1-48) is intended for air-to-ground use with the 5.0 in. FFAR motor against medium and heavy targets. The warhead has a steel case threaded internally at the nose for fuze attachment and externally at the aft end for attachment to the rocket motor. The warhead contains an explosive charge of 9.5 lb of Composition B. Built into the warhead is a MK191 base fuze (not to be removed in field) that is used in conjunction with the MK188 nose fuze or with a steel ogive nose plug. The steel ogive enables the warhead to penetrate heavy targets and to detonate inside.
When the rocket impacts and the fuze functions, the warhead functions as follows:

a. The warhead is detonated by the explosion of the fuze booster.

b. Detonation of the warhead produces effects of blast and fragmentation.

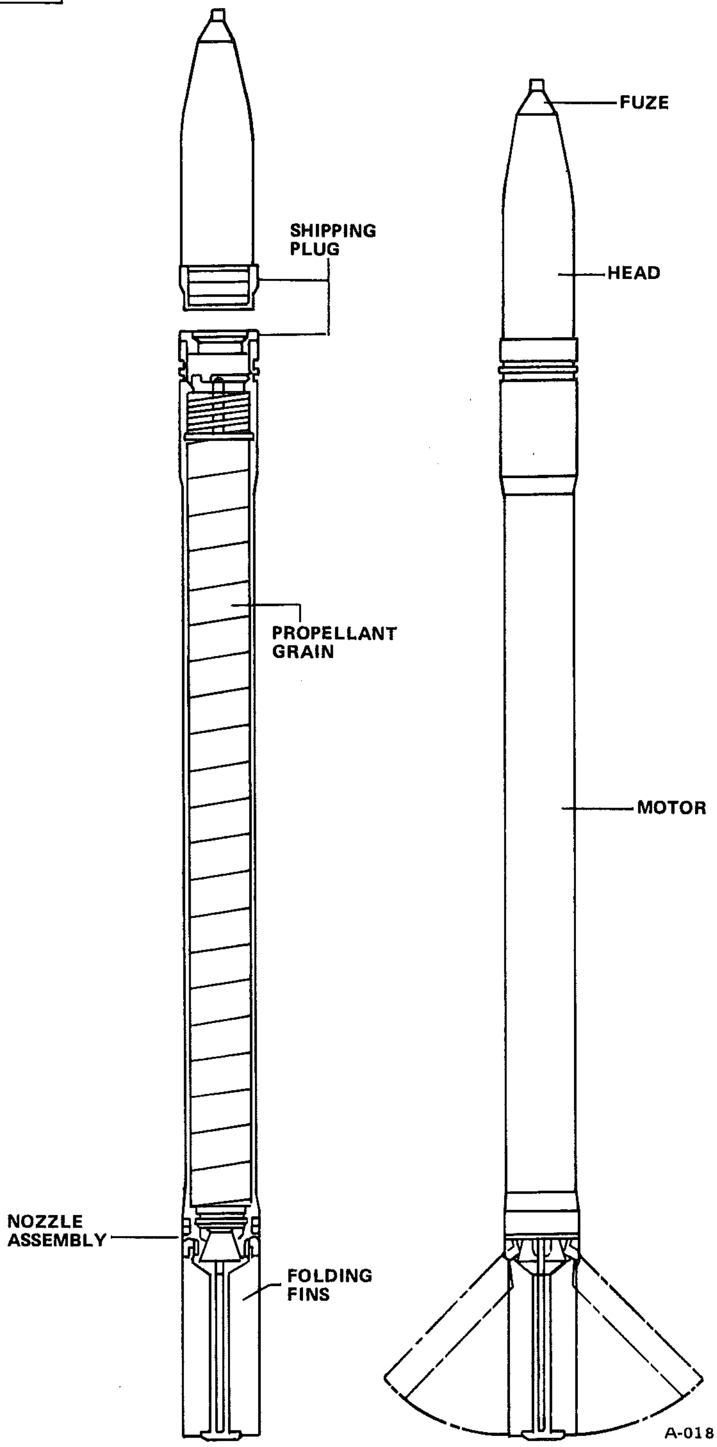
MK188 Rocket Nose Fuze

The fuze (fig. 1-49) is a point detonating fuze used with the 5 in. MK24 Mod 0 and MK32 Mod 0 rocket warheads. The fuze consists of a flat-nosed steel body that encloses an arming mechanism, and an explosive train. The explosive train consists of a primer, detonator, and booster. The primer and detonator are housed in an unbalanced arming rotor. In unarmed condition, the rotor is locked in position so that the primer and detonator are out of line with the firing pin and booster. The fuze is armed by sustained acceleration acting on the unbalanced rotor to bring the primer and detonator into alignment with the firing pin and booster. After arming, the fuze remains armed until impact.
When the rocket is launched, the fuze functions as follows:

a. Inertial forces resulting from rocket acceleration cause setback weights to move aft and free the rotor to turn.

b. Sustained acceleration causes the unbalanced rotor to turn to armed position and lock. In armed position, the primer and detonator are in line with the firing pin and the booster.

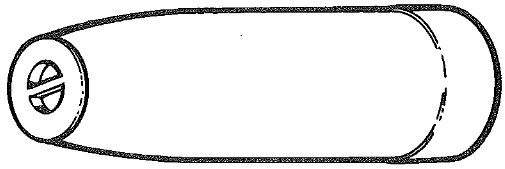
5,0 in. FFAR ZUNI ROCKET



MASS (GROSS)	48.5 kg
DIAMETER	127 mm (5 in.)
LENGTH	.92.215 to 109.347 mm (per head)
RANGE	5 nmi max
VELOCITY	MACH 3
HEAD MODEL	HE (GP), ATAP, ILLUMINATING
POSSIBILITIES	SQ NOSE FUSE BASE FUZE WITH DELAY 0.05 s or VT FUZE

Figure 1-47.

MK 24 MOD 0 HIGH EXPLOSIVE WARHEAD



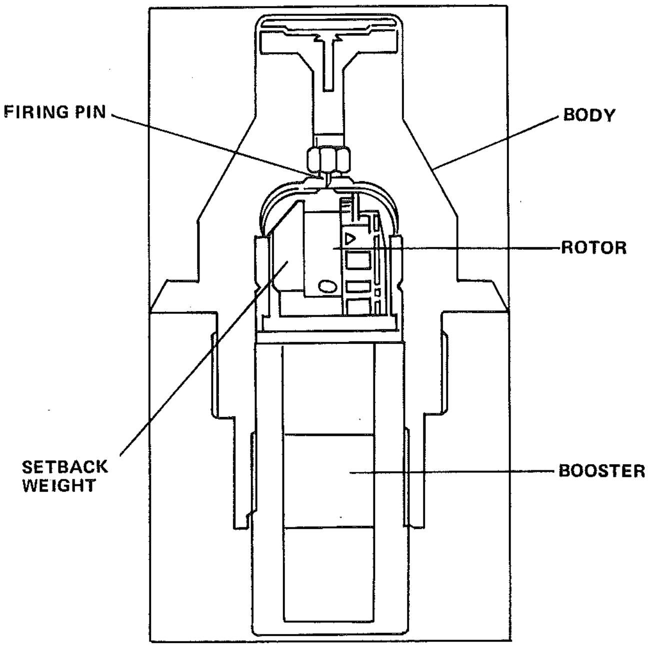
A-016

Figure 1-48.

c. When the fuze impacts the target, the firing pin is driven against the primer.

d. Detonator of the primer initiates the explosive train.

MK188 ROCKET NOSE FUZE



A-017

Figure 1-49.

68 mm FFAR SNEB F1 ROCKET

The 68 mm SNEB F1 rocket (Thomson Brandt) (fig. 1-50) is a folding fin type designed to provide both air-to-air and air-to-ground armament for tactical aircraft. The rocket is filled with a Type 25 Motor and can be configurated with various warheads and fuzes to accomodate the tactical requirements:

- High explosive air-to-air (HE)
- Hollow anti-tank high explosive (HEAT)
- Explosive anti personnel (fragmentation) EAP
- Practice, inert or coloured, explosive, self destructive.

NOTE

> The rockets are fitted with a retaining cap and electrical connections designed for use in rocket launchers JL 110. A different type of retaining cap and electrical connections are provided for rockets used in rocket launcher M 116. These are assembled and fitted at the factory.

The rocket consists of a head, the rocket motor and a venturi tail unit assembly, fitted with 8 stabilizing fins.
The head is screwed into the front end of the rocket motor body. The motor body consists of a light alloy tube, containing a seven star propellant charge coated with a chemical inhibitor.
The venturi tail unit assembly is screwed to the rear of the rocket motor. When the rocket is loaded into its launcher, the stabilizing fins are in the closed position.

68 mm FFAR SNEB F1 Rocket Operation

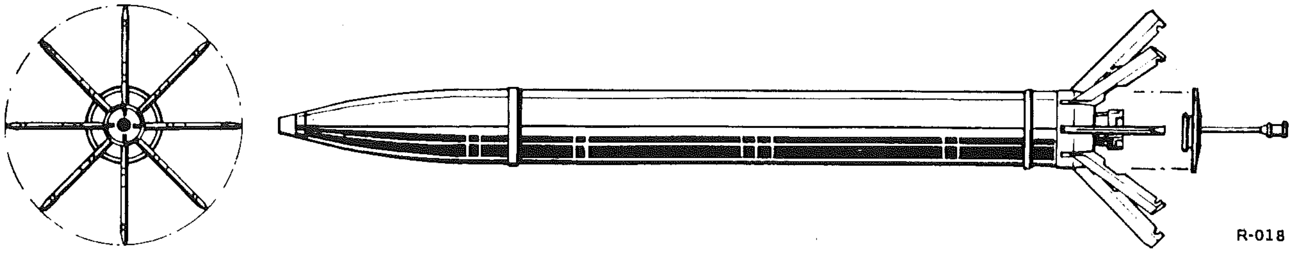
Motor ignition is initiated through two electric resistances, actuated by the firing control and the intervalometer, and imbedded in a black powder charge which in turn ignites the propellant charge. The gases vent through the venturi, propelling the rocket from the launcher. When the rocket is clear of the launcher, the stabilizing fins open under gas pressure. Dependant on the type of head fitted, the rocket will detonate on impact, under the action of a piezo electric fuze.

68 mm FFAR SNEB F1 Rocket Identification

Each rocket is allotted a three figure identity number, i.e. type 251, 252, 253, etc. which identifies each type of rocket.
The first figure indicates the calibre of the rocket. The figure 2 is used to indicate the calibre of 68 mm.

68 mm FFAR SNEB F1 ROCKETS

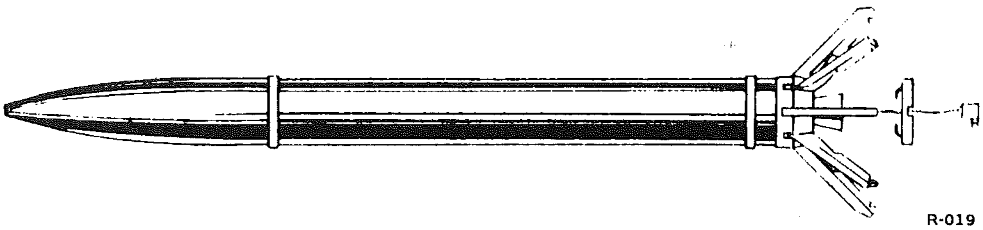
TYPE 251P



MASS. . . . . 4.30 kg
OVERALL LENGTH. . . . . .834 mm

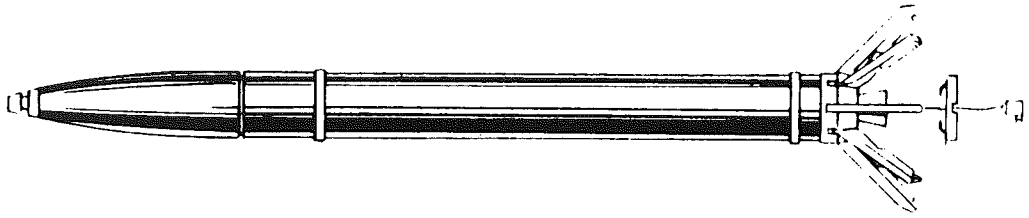
- Motor Type 25 TT
- Warhead Type 21
- Fuze SNEB Type 24

TYPE 252



MASS. . . . . 4.38 kg
OVERALL LENGTH. . . . . .826 mm

TYPE 253 AND 256P



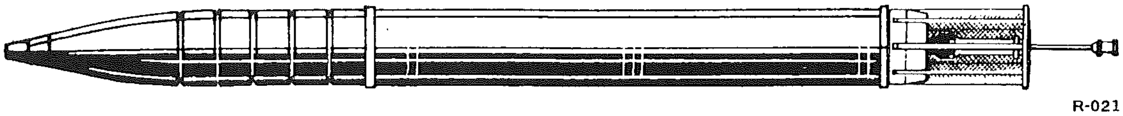
MASS. . . . . .5.05 kg (TYPE 253)
MASS. . . . . 6.25 lg (TYPE 356P)
LENGTH. . . . . .911 mm

- Type 253 : Piezo Electric Fuze
- Type 256P : Fuze SNEB Type 24

Figure 1-50. (Sheet 1)

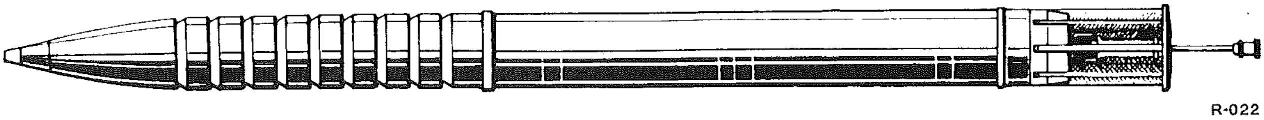
68 mm FFAR SNEB F1 ROCKETS

TYPE 256



MASS. . . . . 6.30 kg
LENGTH. . . . . .936 mm

TYPE 257



MASS. . . . . 8.20 kg
LENGTH. . . . . 1047 mm

Figure 1-50. (Sheet 2)

The second figure indicates the type of fin fitted to the rocket motor; either "umbrella" type 5.
The third figure indicates the type of head.

e.g. Type 251 P

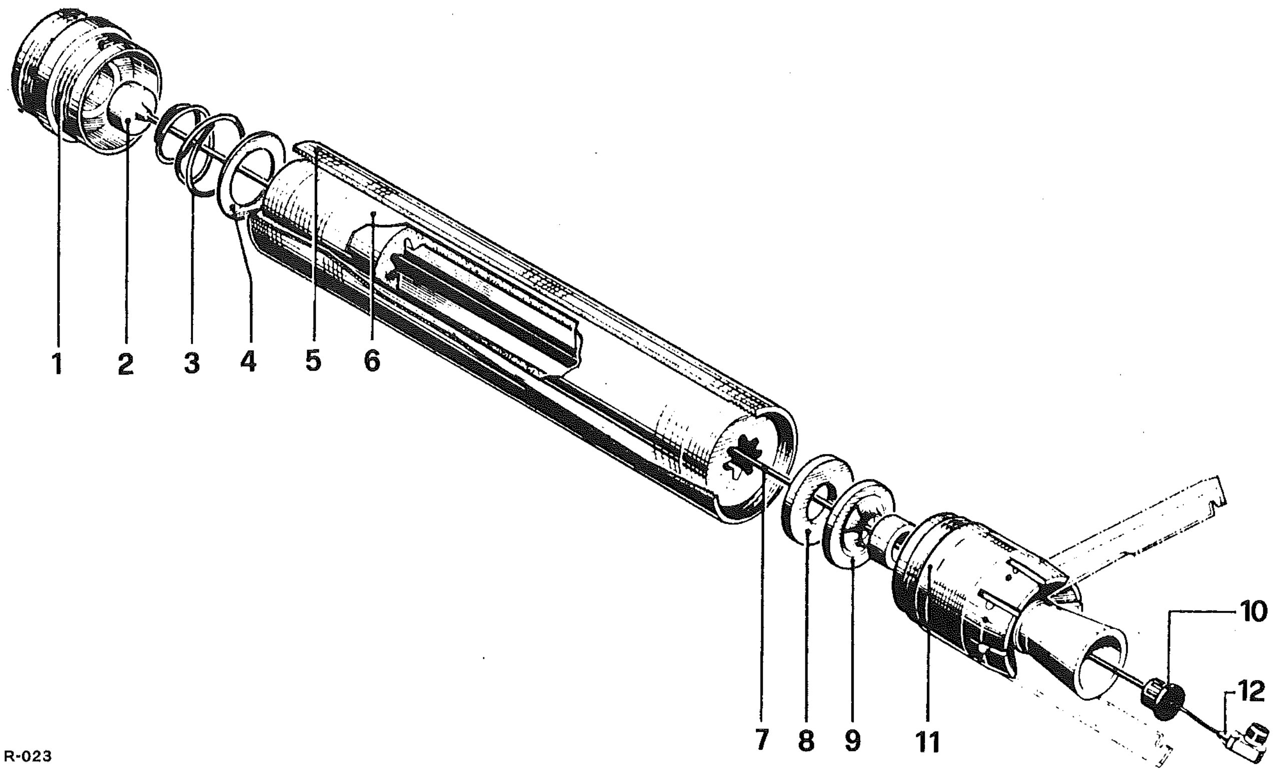
- Calibre - 2 (68 mm)
- Type of fin - 5 (digit of fin type 5)
- Type of head - 1 P (digit of head type 1, air-to-air).

Therefore, a type 251 P rocket is 68 mm fitted with umbrella type fins and the air-to-air H.E. head.
The motor is the type 25 throughout.

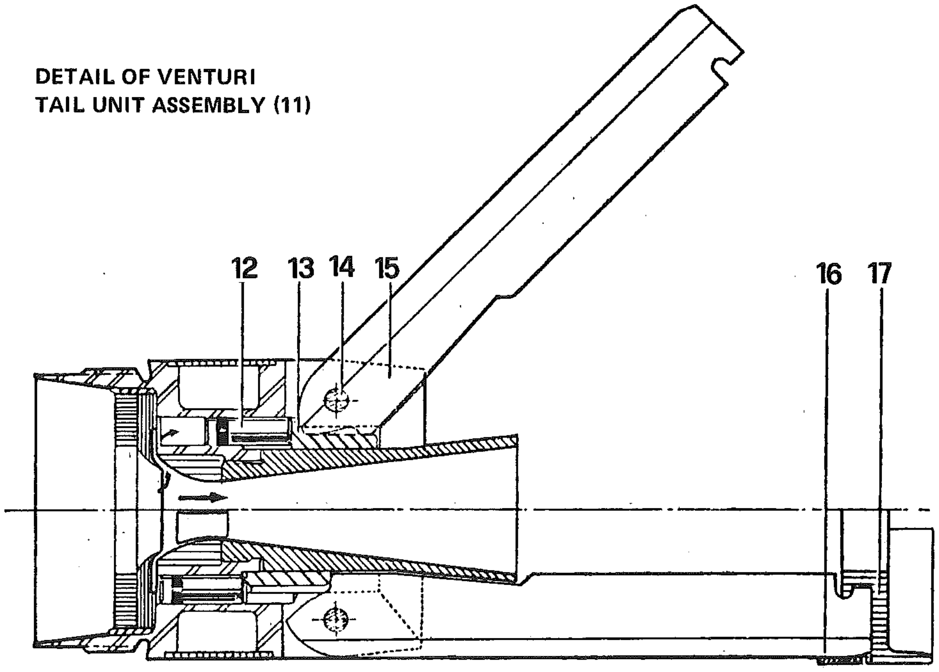
TYPE 25 SNEB ROCKET MOTOR (fig. 1-51)

The motor consists of a tube (5) internally threaded at both ends. The front plug (1) closes the tube and permits the fitting of a different types of head.
The rear assembly of the motor consists of a securing ring (8) a sealing ring (9) and the tail unit venturi assembly (11), which is screwed into the tube. Complete water tightness of the sealing ring is achieved by the use of a rubber plug (10) which is blown out under pressure of the gases on firing.
The powder cake (6) has a star shaped conduit cut through its axis. It is inhibited on its outer surface and is housed in the tube.
The propellant is held in position at the front end by means of a washer (4) and a coiled spring (3). The electric igniter (2) is positioned within the front plug. The electric igniter (2) consists of a celluloid cylindrical container filled with black powder. Two electrical resistances mounted in parallel are fitted inside the celluloid container.
The leads from the igniter are threaded through the propellant and motor assembly to avoid actuation of the resistances by electro-magnetic currents. A knot is tied in front of the rubber plug, to ensure that the resistances will not be extracted from the container when an excessive traction is applied onto the electrical connection terminating the leads. The design of the electrical connection is dependant on the rocket-launcher to be used.
The total mass of the motor is 3.260 kg and includes 1.485 kg of propellant.

TYPE 25 SNEB ROCKET MOTOR



DETAIL OF VENTURI
TAIL UNIT ASSEMBLY (11)



RETAINING CAPS

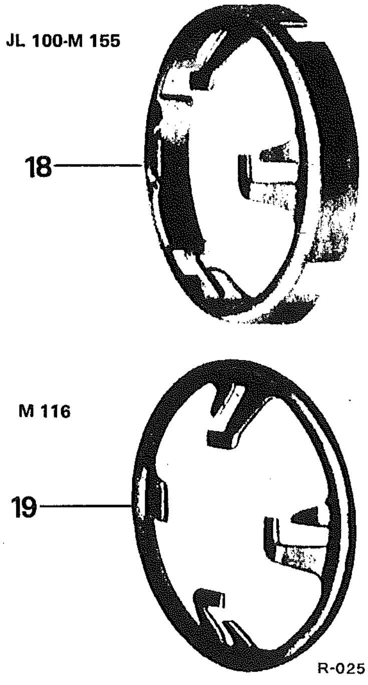


Figure 1-51.

Type 25 SNEB Rocket Motor Operation

By means of an intervalometer, an electric current is passed through the leads to the electric igniter. The two resistance poles in the igniter are coated with a highly sensitive composition. On heating, the composition ignites and activates the black powder, contained in the igniter, which in turn causes ignition in the central channel of the propellant.

During combustion, a constant thrust is maintained, due to the star shaped design of the central channel through the propellant, which gives a constant radial burning throughout its length.

The combustion duration is 0.8 s. at 15°C. The use of TT (all weather) propellant, ensures normal motor functioning for temperature range from -40 to +70°C. In particular, the duration of the combustion remains almost unaffected through these extremes of temperature.

On firing, the electrical igniter activates the black powder which in turn ignites the propellant. The gases pass through the venturi and propel the rocket from the launcher.

As the rocket leaves the launcher, the gases burn through the sealing ring, forcing 4 pistons (12) to rear. The pistons, under pressure of the gases, actuates the opening ring (13) which is in contact with the bents on the eight stabilizing fins (15). As the opening ring is driven to the rear, it causes the fins to rotate on their axis pins (14) until they are locked in the fully open position.

The leading edge of each fin has two chamfers of unequal depth, designed to impart a slow spin to the rocket, thus improving the accuracy. The speed of spin increases in relation to the increase in velocity of the rocket, reaching a maximum of approximately 30 r/s.

During storage and in transit, the fins are held in the folded position by a standard four slotted retaining caps (18 & 19) secured by a plastic ring.

The plastic ring (16) is removed before the rocket is placed in the launcher.

In the event of over-pressure in the rocket motor, and in order to prevent the tube bursting, a deliberate weak point, on the threads of the tube to which the venturi tail unit assembly is screwed, has been provided. With an over-pressure, the rocket will break at this point, blowing off the tail unit assembly, causing an immediate fall in pressure.

WARHEADS FOR 68 mm FFAR SNEB F1 ROCKET

SNEB Type 21P Warhead (fig. 1-52)

The head, made of a light alloy, consists of a rear cylindrical body (6) and an ogive-shaped body at the front (2). The front of the head houses the piezo-electric generator (1) and at the rear the safety arming unit (7) together with the steel plate (5) and the booster charge of 83.5 g of RDX/WAX (4).

For description and functioning of the piezo-electric generator and safety arming unit see description of head Type 23. These components are identical to those contained in the hollow charge head.

The head contains 440 g of poured high explosive (3), consisting of 60/40 RDX/TNT. The head is internally threaded at the rear, enabling it to be screwed to the rocket motor.

SNEB TYPE 21P WARHEAD

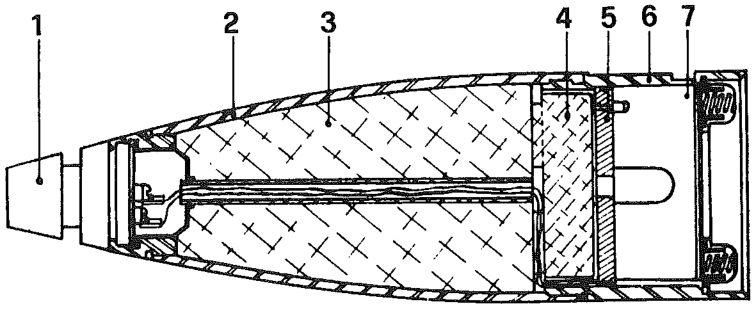


Figure 1-52.

The complete head has a total mass of 1.050 kg.

Operation - This type of head is fuzed with a piezo-electric fuze, which is an integral part of the head, and as such cannot be removed.
On impact, the distortion of a barium titanate crystal, produces an electrical umpulse which is transmitted to the detonator, which in turn detonates the main charge in the head.
Arming of the fuze and subsequent ignition is only possible when the different mechanical safety devices have functioned, allowing the electrical fuze circuit, and the explosive chain, to be completed.
This type of head has, on impact a very high blast effect and distruptive effect against light-alloy plates.

SNEB Type 23 Warhead (fig. 1-53)

The H.E. hollow charge head type 23 with secondary anti-personnel effect H.E.A.T. warhead, made of light alloy, is ogive-shaped (4) at the front, terminating in a steel body (7) at the rear.
The front of the head houses a crystal of barium titanate (2) enclosed in obturator (1). The rear is internally threaded enabling the head to be screwed on to the rocket motor.
The steel part of the body houses the hollow charge cone (5) and its plug (8), and the high explosive (6 and 9). An electrical detonator is housed in a shutter type mechanism (12) and is connected to the barium titanate crystal, by two connecting wires (3).
On impact, the piezo-electric crystal is distorted, creating an electrical impulse, which is transmitted to the detonator (13) housed in the safety arming unit (12).
The charge contained in the head consists of two parts:

1. 215 g of poured 60/40 RDX/TNT between the copper cone (5) and the steel body (7).
2. 83.5 g cake of compressed RDX/Wax (9) contained in a cup behind the cone.

This charge is isolated from the detonator by a steel plate (10) which is bored through the centre to take a tetryl relay pellet (11).
On the fuze arming, the detonator is brought into line with the relay pellet. This movement of the detonator makes the electrical circuit, between it and the piezo-electric crystal in the nose.

In the non-armed position, the detonator is off-set from the explosive train, and is masked by the steel shutter. On the extremely unlikely event of the detonator functioning, it cannot initiate the main explosive.

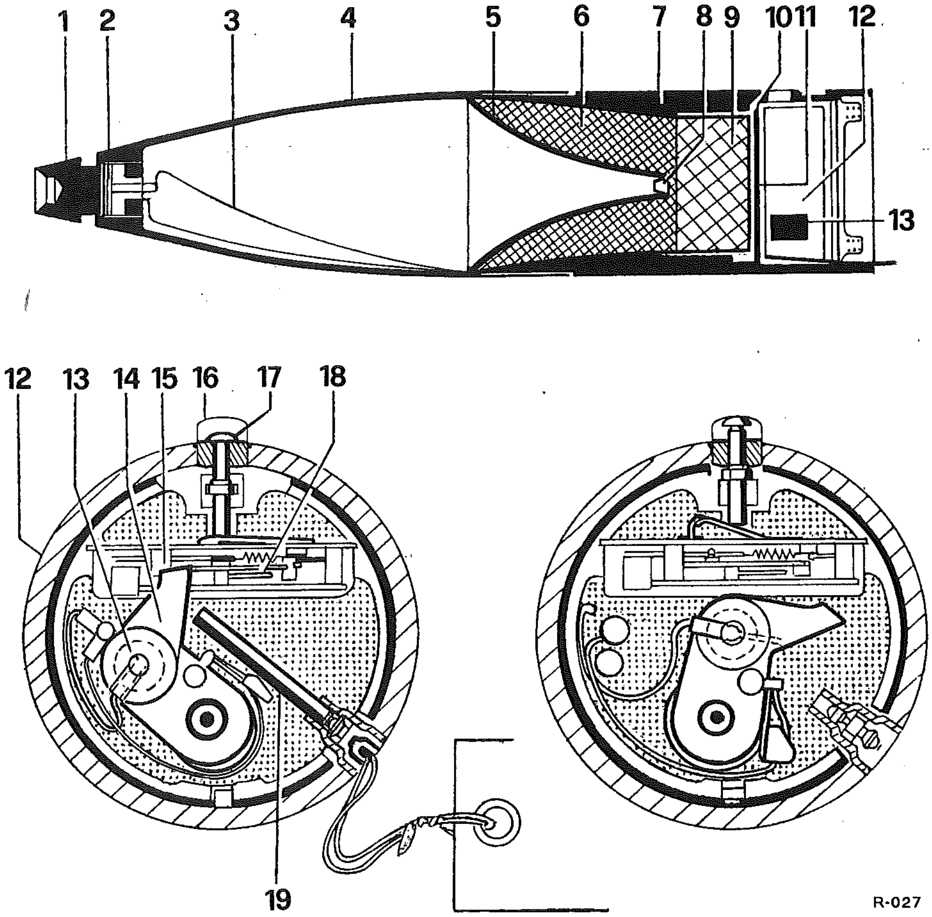
Operation - This type of head is fuzed with piezo-electric fuze, which is an integral part of the head, and as such cannot be removed.
On impact, the distortion of a barium titanate crystal, produces an electrical impulse which is transmitted to the detonator, which in turn detonates the main charge in the head.
Arming of the fuze and subsequent ignition is only possible when the different mechanical safety devices have functioned, allowing the electrical fuze circuit, and the explosive chain, to be completed.
In addition to the armour piercing capabilities of the head, the rear portion gives a considerable anti-personnel effect on break up.
When the H.E. filling detonates under the action of the super-quick detonator incorporated in the safety arming unit of the piezo-electric fuzing system, a thin high velocity jet is formed. This jet consists of a mixture of H.E. gases and fine particles of the copper liner and travels at a very high velocity.
On striking the armour the jet exerts a very high pressure which displaces the metal and axial penetration of up to 400 mm thick armour can be achieved.
The perlitic malleable cast iron body of this head enables to produce an even distribution of fragments in size and weight as well as a very effective spatial distribution.
The velocity of the fragments is such that they are still dangerous against personnel at distance larger than 30 m from the point of the impact.

SNEB Type 26P Warhead (fig. 1-54)

The anti-personnel, type 26P, warhead is made of a perlitic malleable cast-iron ogive-shaped body (2) at the front on to which is screwed a steel cylindrical body (6) at the rear.
The front of the head houses the piezo-electric generator (1) and at the rear the safety arming unit (7) together with the steel plate (5).
The explosive charge is composed of two fillings:

- a booster charge of 52 g of RDX/WAX.

SNEB TYPE 23 WARHEAD



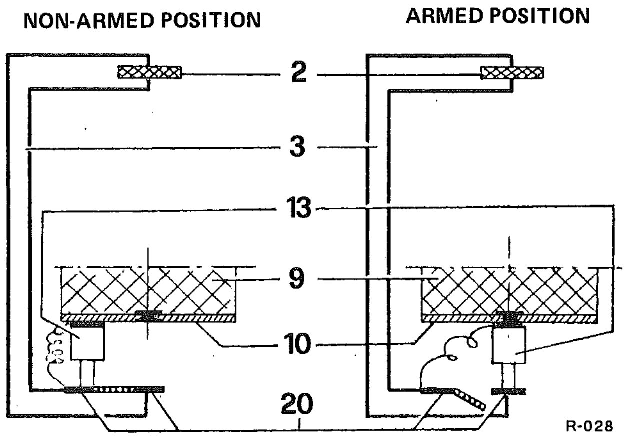


Figure 1-53.

SNEB TYPE 26P WARHEAD

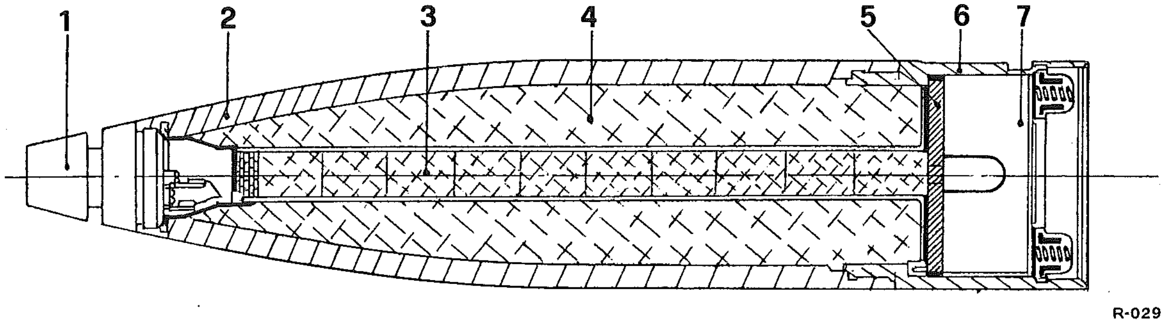


Figure 1-54.

- a main filling of 520 g of TNT.

For description and functioning of the piezo-electric generator and safety arming unit, see previous paragraph.
These components are identical to those contained in the hollow charge head type 23.
The head weights 3 kg.

Operation - This type of head is fuzed with piezo-electric fuze, which is an integral part of the head, and as such cannot be removed.
On impact, the distortion of a barium titanate crystal, produces an electrical impulse which is transmitted to the detonator, which in turn detonates the main charge in the head.
Arming of the fuze and subsequent ignition is only possible when the different mechanical safety devices have functioned, allowing the electrical fuze circuit, and the explosive chain, to be completed.

The perlitic malleable cast iron body of this head enables to produce an even distribution of fragments in size and weight as well as very effective spatial distribution.
The velocity of the fragments is such that they are still dangerous against personnel at distance larger than 30 m from the point of impact.

SNEB Type 27 Warhead (fig. 1-55)

The anti-personnel, type 27, warhead comprises a steel ogival body (2) which is provided of pre-fragmentation grooves. In the front zone it is closed by a cup (1) also used to lodge the fuse. The rear of the body is filled with explosive comprising a booster charged with 135 g of toluene (3) and a charge of 950 g (4). On the rear, a threaded zone permits the installation of the warhead on the rocket motor. A metallic disc is used as rear lock.

SNEB TYPE 27 WARHEAD

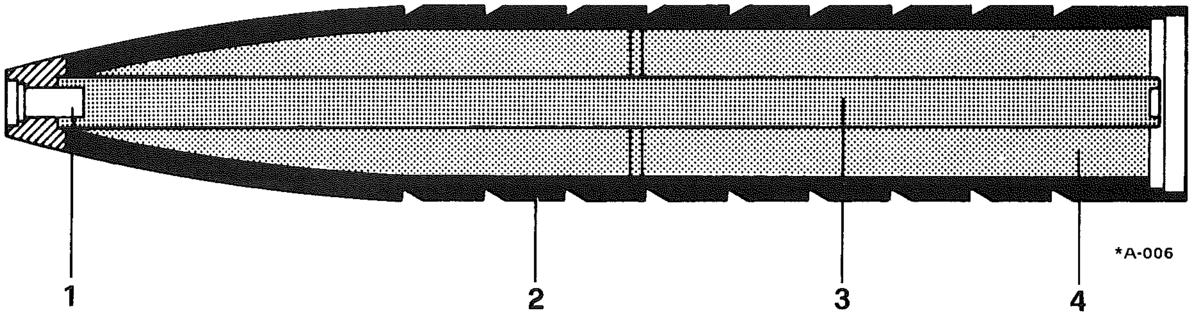


Figure 1-55.

The total mass is 4.653 kg including the SNEB type 22 fuse.
The warhead type 27 total length is 447 mm.
Operation - This type of head is fuzed with piezo-electric fuze, which is an integral part of the head, and as such cannot be removed.
On impact, the distortion of a barium titanate crystal, produces an electrical impulse which is transmitted to the detonator, which in turn detonates the main charge in the head.
Arming of the fuze and subsequent ignition is only possible when the different mechanical safety devices have functioned, allowing the electrical fuze circuit, and the explosive chain, to be completed.
The perlitic malleable cast iron body of this head enables to produce an even distribution of fragments in size and weight as well as very effective spatial distribution.
The velocity of the fragments is such that they are still dangerous against personnel at distance larger than 30 m from the point of impact.

SNEB Type Self-Destruction Marker (fig. 1-56)

The self-destruction marker type 24 comprises an ogive (1) in light alloy which is screwed on the tube (2) and at the other end is screwed on the plate (3). On the rear, a tube (2) is provided with eight holes for fire transmission from the fuse to the explosive charge; these holes are closed by cardboard plugs (4). The assy is sealed by means of a plug (5) and by a toric connection (6).
The warhead is charged with a colored smoke composition of 170 g, the colours yellow, red and green are the most frequently used.
Before being charged on the rocket launcher the warhead is provided of a SNEB, type 21 fuze. This fuze is actuated at a distance that can be preselected, and ignites the charge, which is detonated obtaining a colored smoke having about one metre of diameter, the persistence of which is of various seconds.
The mass is 634 g and the lenght is 178 mm.

FUZES FOR SNEB WARHEADS

SNEB Type 21 Fuze (fig. 1-57)

The SNEB type 21 fuze, is used on the self-destruction colored marker type 24. It comprises the body (16) which has inside two stop plates (20), and an armament ring (5-17-22) provided with two grooves (22) and a firing pin (2). In the front portion of the body is screwed a detonator carrier (21) having in the bottom a transversal slot (4) for the displacement of the detonator (18), under the action of the spring (19); on the top the body loadges a black powder Booster (23); the front zone of the body is closed by a plug (24) incorporating the

SNEB TYPE 24 SELF - DESTRUCTION MARKER

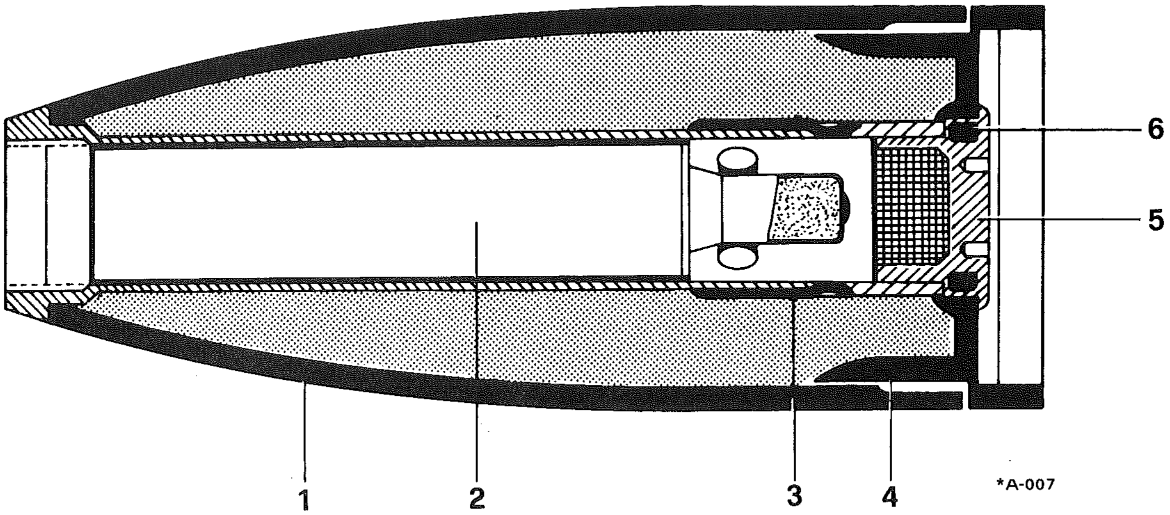


Figure 1-56.

SNEB TYPE 21 FUZE

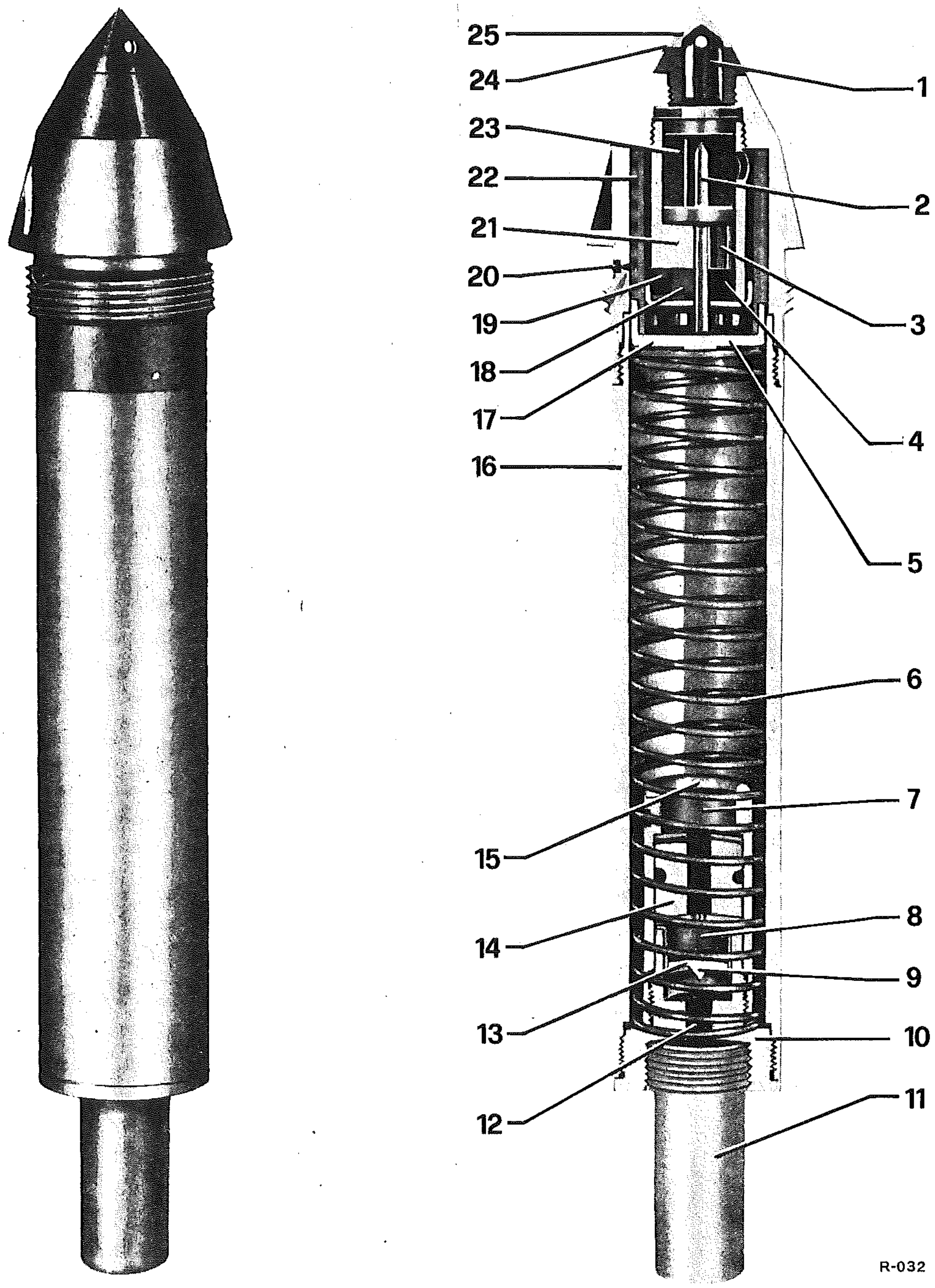


Figure 1-57.

vents (25) and a black powder booster (1). The armament ring (5-17-22) is provided with an armament spring (6). The rear portion of the body is provided with a plug used to support a time delay (10) comprising a black powder booster (7), a time delay (14), a firing pin (13) filled with black powder (8) and a detonator charged with black powder (11).

After the rocket is fired, the armament ring (5-17-22) acts on the spring (6) till its lower zone (17) comes in contact with the

surface (15) of the plug which carries the time delay (10). During this movement the armament ring displaces the firing pin (2) and disengages the detonator (18) that will be placed at the bottom of the slot (4) under the action of its spring (19). At this moment the fuse is armed and the armament train is in line. After the positive acceleration has ended, the armament spring (6) moves forward the armament ring (5-17-22) integral with the firing pin (2). This will strike the detonator (18) that starts the ignition in the black powder (23) and (1), the flame through the holes (3) and (5) sets fire to the device (7) and the delay (14); this delay can be adjusted to be activated at 0,8 2 or 3 seconds from the acceleration completion. The PN which is contained in the cup (13) shatters the same and ejects the item (9) against the detonator (12) that sets to fire the detonator charged with black powder (11).
In case of accidental drop, the armament ring (5-17-22) cannot be lowered because the spring (6) and the lugs (20) prevent it.

SNEB Type 22 Fuze (fig. 1-58)

The SNEB type 22 fuze is used in configuration with the anti-personnel warhead type 27. It comprises three main items:

1. The fuze head which is of steel.
2. The detonator in light alloy, which is charged with lead azide.
3. The booster device of light alloy charged with compressed tetryl.

This fuze, which is utilized on 20 mm rounds, is actuated at impact moment. The type 22 mass is 33.4 g.

Piezo-Electric Fuze

This fuze is integral with the warhead type 23.
Description and operation are illustrated together with type 23 warhead.

SNEB Type 24 Fuze (fig. 1-59)

In A condition the fuze is ready for firing. The projection (17) of the firing pin (6) increases the sensitivity of the fuze that is sealed by the item (1).
During the rocket motor operation, the parts of the fuze are in the position illustrated in B condition. The armament ring (2) moved by the force of inertia compresses the spring (12); the tabs (19) of the ring (18), which is connected with the ring (13), are engaged with the armament ring groove (4); the ball (15) is on the groove (3).
After the end of the position acceleration as shown in C condition, the spring (12) moves forward the armament ring (2) and the ring (13) till the item (1) with the interposition of the ball (15). The balls (7) are disengaged and, under the deceleration action they will be moved in the position illustrated in C condition. At this moment the fuze is armed and will be operated at the impact.

SNEB TYPE 22 FUZE

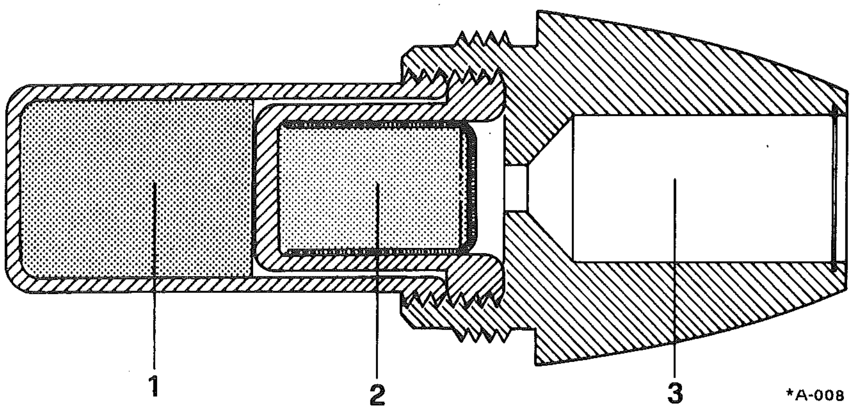


Figure 1-58.

SNEB TYPE 24 FUZE

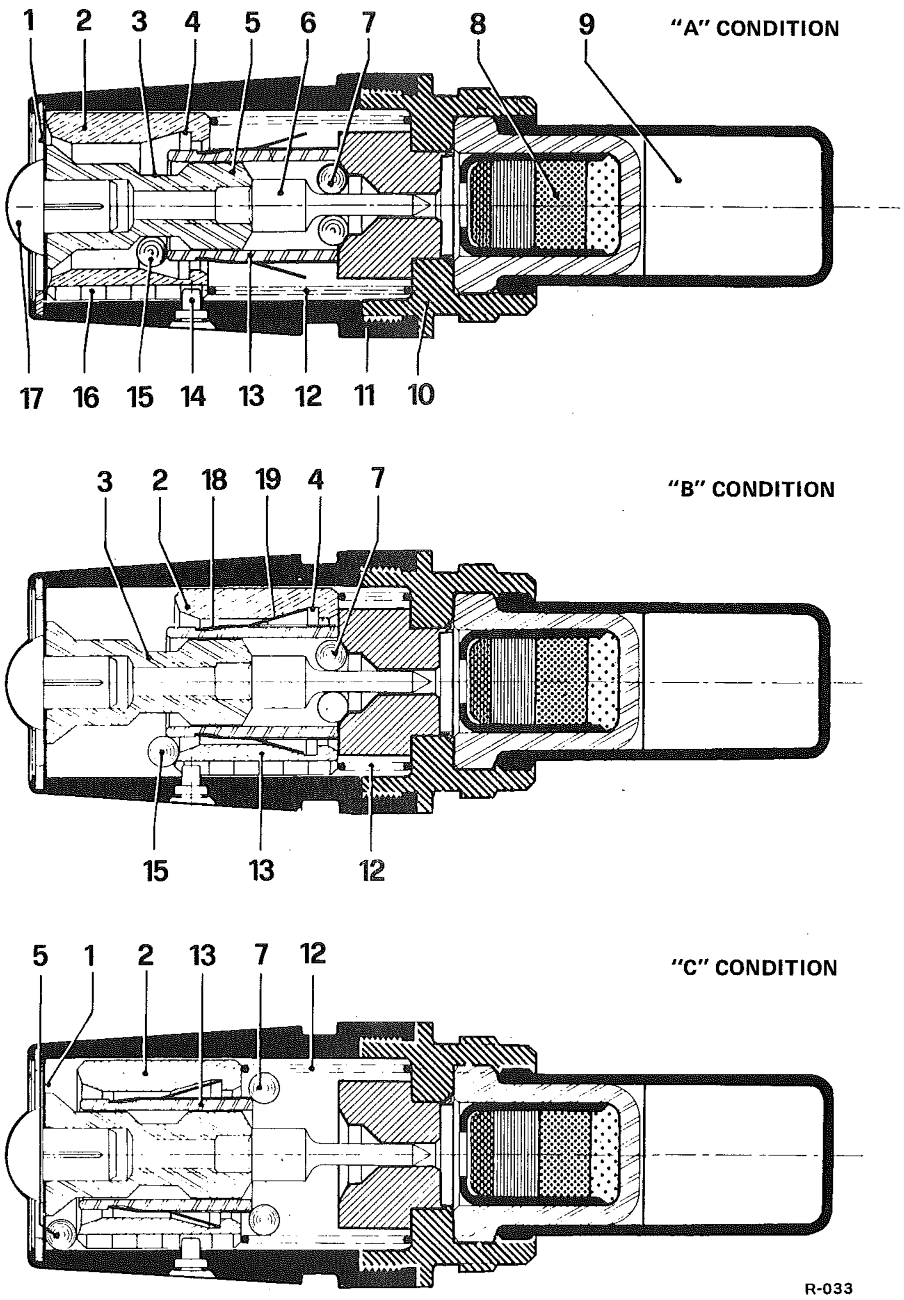


Figure 1-59.

Safety is obtained because:

1. In case of accidental drop the armament ring is maintained in position by the spring (12) and by the lugs (14).
2. In case of accidental drop on the nose the firing pin (5) is prevented from moving forward by the balls.
3. Safety when on the launcher. In case of accidental decrease of speed inside the launcher with a premature disengagement of the safety balls, the fuze is so featured that the percussion is avoided when the rocket is again accelerated.

The mass of this fuze when ready to be fired is 41 g.

When not armed the firing pin (6) integral with the nose (11) cannot reach the detonator (8) because on its way are placed the balls (7). These are maintained in position by means of a ring (13) which is locked by its ball (15) inside the groove (3) of the firing pin (3). The locking action is also effectuated by the armament ring.

MATRA 155M ROCKET LAUNCHER (fig.1-60)

The model 155M rocket launcher is designed for air-to-air and air-to-ground use with 18 rockets, SNEB 68 mm, type 253 anti-personnel, rockets are fired through an intervalometer, step type, mounted inside the launcher.

MATRA F2 ROCKET LAUNCHER (fig. 1-61)

The model F2 rocket launcher is a six tubes launcher, designed for air-to-air and air-to-ground operations with 68 mm SNEB rockets.
A step type intervalometer, mounted inside the launcher provides to fire the rockets at 0.03 s interval.

ROCKET OPERATION (ANY TYPE)

The rocket firing sequence is determined by an intervalometer comprised in each container.
The rocket containers are attached to the pylons through the pylon rack and are laterally stabilized by the sway braces.
Firing of the FFAR rockets is possible only on condition that the landing gear control lever is set at UP. On the ground, the circuit can be tested by moving the switch to ON and holding it there. The FFAR rocket circuit is powered from the secondary bus bar. Arming of the FFAR rocket circuit for operation is made by moving the "ARM" switch to ARM and moving up the store arming switches corresponding to the rocket launchers that it is desired to fire. The number of rockets to be fired in each salvo is selected through the "SEQUENCE" switch. With the switch in the SINGLE position, a single rocket is fired from each selected rocket container whenever the firing button switch is depressed; in the RIPPLE position, the rockets will fire continuosly from the selected containers until the firing button is released. This is due to a relay which provides a second power supply for the container during the firing of a burst of rockets. In case a single rocket is fired, the second power supply to the container is interrupted by a relay.

NOTE

Not all types of rocket container incorporate provisions for in-flight selection of the number of rockets to be fired. On many types this selection must be made on the ground by means of a special switch comprised in the rocket container.

Pushing the firing button switch feeds current to the rocket container through relay A15. The rockets will thus be fired in the sequence determined by the rocket container intervalometer and in the number preset through the "SEQUENCE" switch.

WARNING

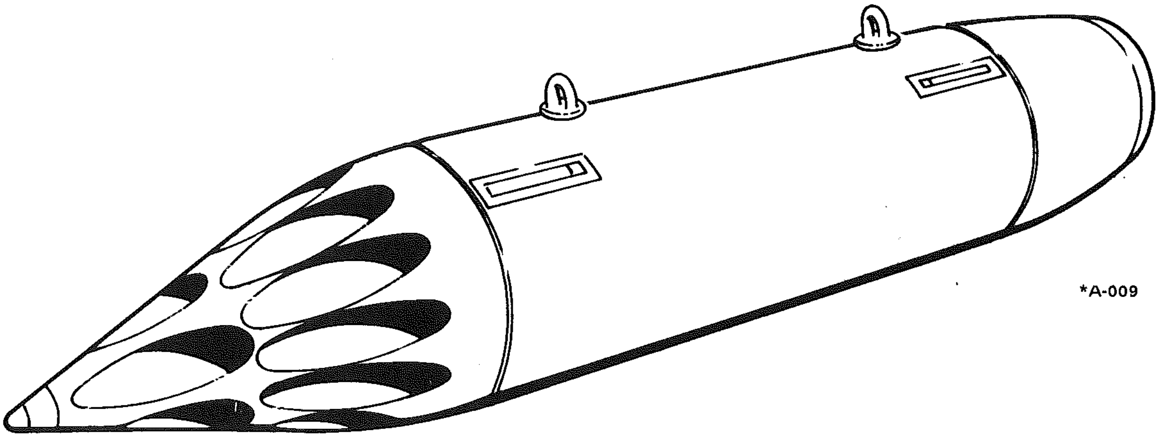
When more than two rocket launchers are carried, simultaneous firing action is allowed only by two symmetrical launchers a time.

FLARES

MK 24 AND LUU-1/B FLARE

The LUU-1/B flare marker and the MK24 illumination flare, are similar with a different candle/parachute assembly installed (figure 1-62). It is designed to be aircraft launched. The marker consists of an outer aluminum cylindrical container that encloses an ejection fuze, an ignition fuze, a lanyard, a parachute, and a candle (illuminating composition). During handling, a safety cotter pin is inserted through the ignition setting dial to keep the marker from accidentally being functioned. The LUU-1/B flare marker is 4.87-inch in diameter by 36-inch long and weights 26 lb. The marker is ejected from the case by a preset variable delay time fuze. The marker is then ignited by a preset variable delay time fuze. The ejection delay, which is adjustable from 5 to 30 s., allows the marker to fall a predetermined distance from release to ejection and suspension of the candle. The ignition delay, which is adjustable from 10 to 30 s., allows the suspended candle to fall a predetermined distance before igniting. When released, the marker falls, exerting a force in excess of 12 lb on the arming lanyard, thus pulling it from the marker and arming the ejection delay fuze.

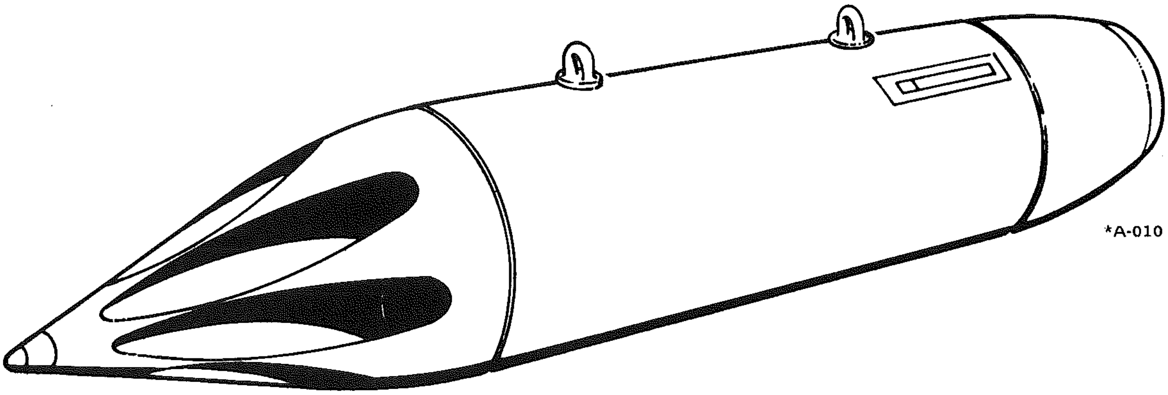
MATRA 155M ROCKET LAUNCHER



MASS, EMPTY	205 lb
MASS, FULL (Rockets Type 253)	407 lb
LENGTH	92.29 in.
DIAMETER	16.14 in.

Figure 1-60.

MATRA F2 ROCKET LAUNCHER



MASS, EMPTY	26 kg (63 lb)
MASS, FULL (Rockets Type 253)	58 kg (130 lb)
LENGTH	1.450 m (57 in.)
DIAMETER	0.246 m (9.7 in.)

Figure 1-61.

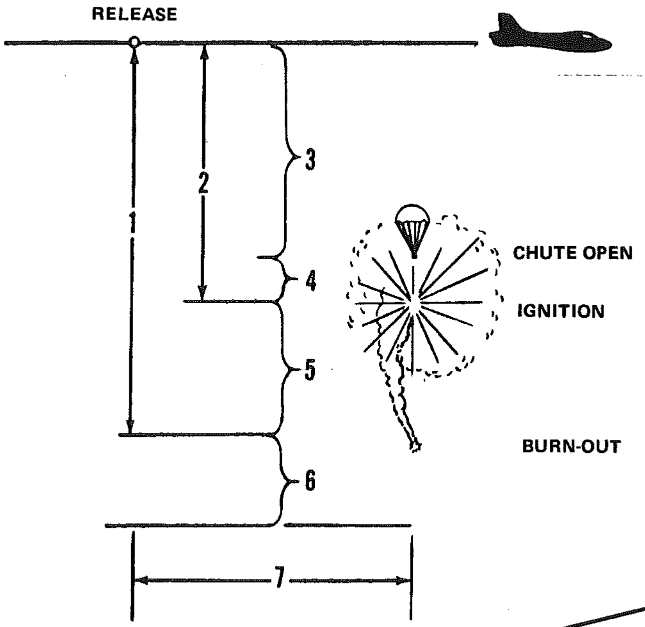
When the preset time has lapsed, the ejection delay fuze ignites the ejection disc: the ejection disc then ignites the ejection fuze, ejecting the ignition fuze, candle and parachute from the outer container. Upon clearing the outer container, the container falls away, allowing the parachute to open and suspend the ignition delay fuze and candle and simultaneously arms the ignition delay fuze. When the ignition delay preset time has lapsed, the ignition delay fuze activates a transfer disc, which initiates an ignition disc that ignites the candle and causes separation of the ignition fuze from the candle. The parachute is a cruciform design, which utilizes 6-foot by 2-foot panels designed to provide a 30 ft/s rate of descent and to snag in the top of heavy foliage, making it useful in jungle areas. A steel suspension cable links the parachute and the wooden suspension block, which is located on the bottom of the candle. The suspension cable passes through the center of a 2.75-inch diameter protective core in the center of the candle. The suspension cable extends six feet from the top of the candle to a point where it is connected to eight 6-foot shroud lines. The candle is inverted (burning surface on the end connected with the parachute) to reduce the chances of snuffing out the flare on ground impact. Since the ignition of the candle takes place at the end opposite to the ignition fuze, a double ply quickmatch train is coilded inside the ignition fuze cavity and threaded through the protective center core of the candle. The quickmatch is extended into the cavity and is coiled over a hot--burning material called the first fire mixture. The candle has a 1/8-inch coating of the first fire mixture. Formed in the candles are two 1/2-inch in diameter by 3-inch long holes filled with a first fire mixture having a 2 min burn time which increases the capability of the burning candle to withstand ground impact and continue burning. The candle is designed to burn for 210 s on the ground, providing an easily distinguishable red light. The candle is 27-inch long by 4-inch in diameter and weights 19 lb. It contains 16 lb of flare composition. It is intended that the color be distingui_ shable in the presence of illumination flares. The level release tables for the LUU-1/B flare (see Volume 2) provide horizontal travel and vertical drop prior to flare ignition for the available range of ejection and ignition fuze settings. During mission planning, a release altitude, an ejection fuze setting, and an ignition fuze setting must be selected that will assure flare ignition prior to ground impact. After flare ignition the flare has a rate of descent of approximately 15 ft/s. The total time of fall is the sum of the ejection fuze setting, plus the ignition fuze setting, plus the time of fall after ignition based on a rate of descend of 15 ft/s.

DELIVERY OF MK24, LUU-1/B FLARES

The delivery aircraft should approach the target in level flight at the preplanned release altitude. The MK24 flare profile and parameters are illustrated in figure 1-76. Release airspseed is not a critical parameter. Release altitude is critical only when it is desirable to have flare burnout above the ground. The flare dispensing table (6-19) provides the minimum release altitude AGL that will insure flare burnout before impact. The desired burnout altitude AGL must be added to the minimum release altitude AGL. It is recommended that release altitude be planned to provide burnout of the flare from 300 to 1000 ft above the ground. The flare dispensing table also provides the horizontal distance traveled and vertical drop of the flare prior to ignition. The flare ejection fuze delay time and the flare ignition fuze delay time are set according to the mission requirements and the data on the flare dispensing table. To properly position the flare at ignition, rangewind effect and crosswind offset (ft) may be determined by multiplying the rangewind or crosswind component (kt) time 1.7 times the sum of the ejection and ignition fuze delay settings.

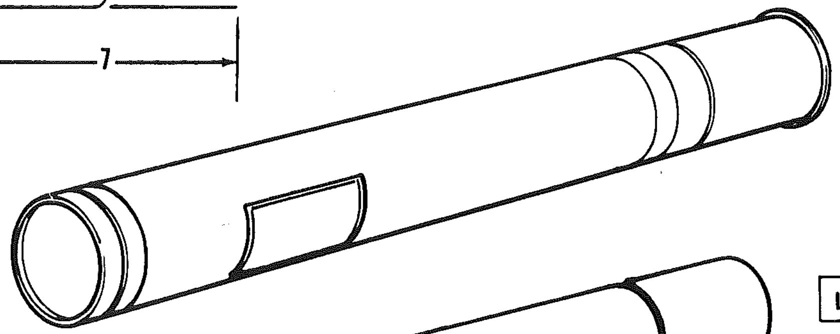
The MK24 and LUU-1/B flare delivery wind correction chart (figure 1-63), can be used for determining these wind corrections. During the burning time, the MK24 Mod 2 will drift 250 ft per knot or effective wind; the Mod 3, 300 ft per knot and the Mod 4, 350 ft per knot. Both of these corrections should be used. For example, for MK24 Mod 2 flare assume a desired release altitude of 5000 ft and desired burnout altitude of approximately 700 ft. Assume a release velocity of 300 KTAS. From the MK24 flare release tables (table 6-19) the timer settings, vertical drop, and horizontal range can be determined. For a release altitude of 5000 ft and a burnout altitude of 700 ft, a vertical fall of 4300 ft is required. From the table it can be determined that an ignition fuze setting of 10 s and an ejection fuze setting of 15 s is required. For a 15 s ejection fuze setting and 300 KTAS the horizontal range is 2370 ft. For these timer settings the vertical drop to flare ignition of 2050 can be determined. There fore, the flare will ignite at approximately 3000 ft. For this

MK24 AND LUU-1B FLARES



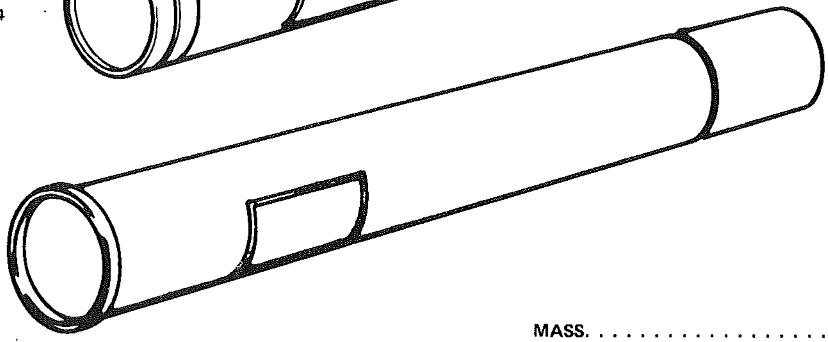
USED WITH BOMB/FLARE DISPENSER 11B29-003
(see fig. 1-4 "Low Level Bombing")

1. MINIMUM RELEASE ALTITUDE AGL REQUIRED TO PROVIDE FLARE BURNOUT
2. VERTICAL DROP TO FLARE INGNITION
3. EJECTION FUZE DELAY TIME
4. IGNITION FUZE DELAY TIME
5. FLARE BURNING TIME
6. DESIRED FLARE BURNOUT HEIGHT AGL
7. HORIZONTAL FLARE TRAVEL PRIOR TO IGNITION



MK24

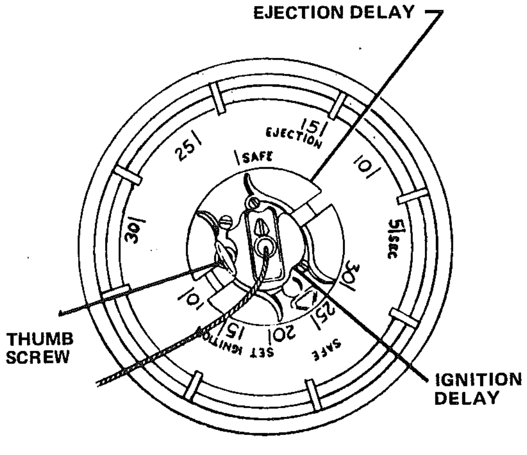
R-034



LUU-1B

R-035

	MK24		LUU-1/B
	Mod. 3	Mod. 4	
MASS	27 lb	27 lb	28 lb
LENGTH	36 in.	36 in.	36 in.
DIAMETER	4.9 in.	4.9 in.	4.9 in.
FLARE DURATION	180 s	210 s	210 s



TO SET FUZES

1. REMOVE THUMB SCREW
2. DEPRESS EJECTION DIAL AND TURN CLOCKWISE TO THE DESIRED TIME SETTING, RELEASE PRESSURE AS SETTING IS APPROACHED. DIAL MUST RETURN TO UPMOST POSITION AFTER SETTING.
3. DEPRESS IGNITION DIAL AND TURN CLOCKWISE TO THE DESIRED TIME SETTING, RELEASE PRESSURE, AS SETTING IS APPROACHED, DIAL MUST RETURN TO UPMOST POSITION AFTER SETTING.
4. POSITIVE STOP SAFETY PIN MUST BE ALIGNED AS A FINAL OPERATION PRIOR TO FIRING.
5. IF FLARE IS NOT FIRED, REPLACE SAFETY PIN.
6. TO RESET ON SAFE, DEPRESS AND TURN IN COUNTERCLOKWISE DIRECTION TO SAFE.

Figure 1-62.

FLARE DELIVERY WIND CORRECTION CHART

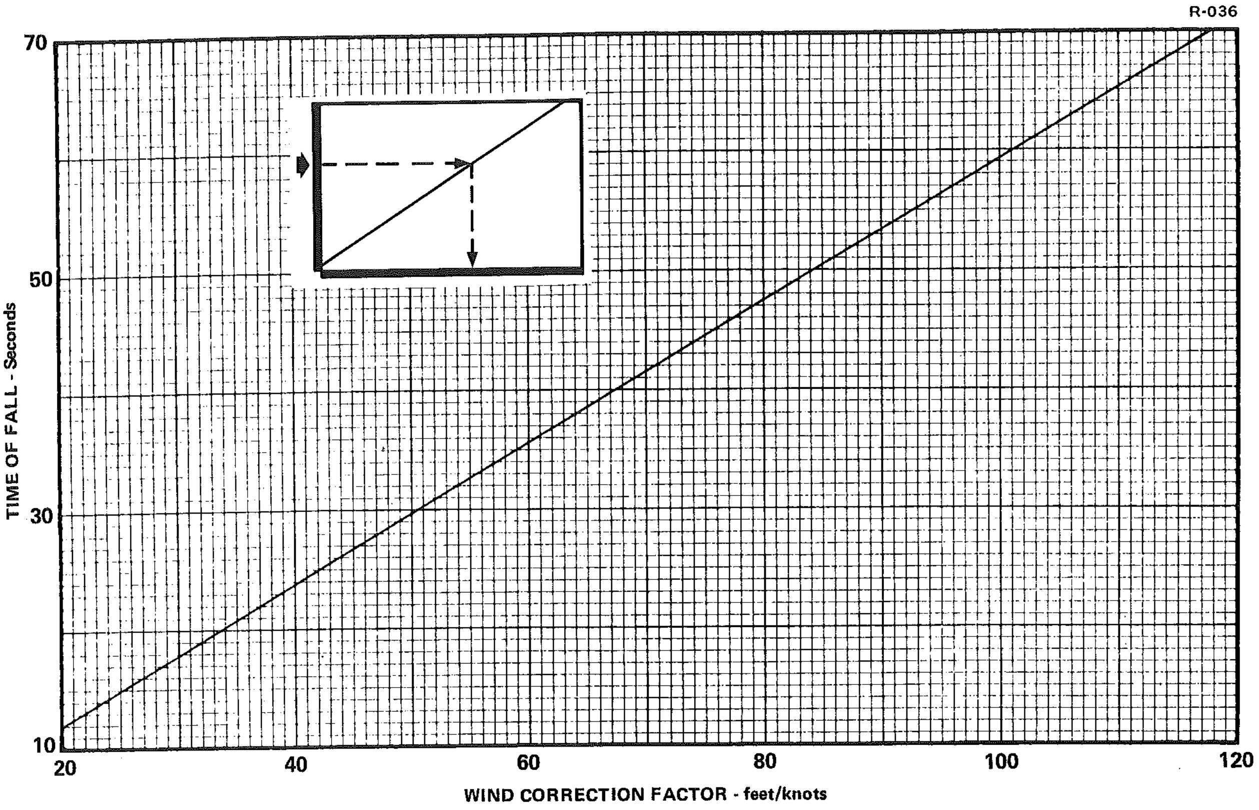


Figure 1-63.

LUU-2B FLARE TIMER SETTING

DESIRED FALL - ft	SET TIMER POINTER TO
500	500
1500	1500
3000	3000
4500	4500
6000	6000
6500	7500*
7500	9000*
8500	10 500*

* DROP DATA

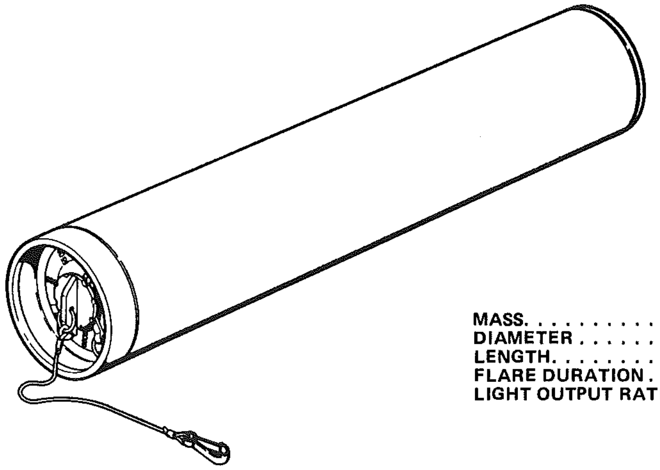
Figure 1-64.

example use the winds at 5000 ft to correct for drift from release to flare ignition, and use winds at 3000 ft to correct for drift from flare ignition to burnout. Assume a 12-knot tailwind, and an 8-knot crosswind at release altitude. At flare ignition (3000 ft) assume a 10-knot tailwind and a 5-knot crosswind. To correct for wind from release to flare ignition add the ignition fuze setting (10 s) and the ejection fuze setting (15 s) to obtain a total time of 25 s. Enter the MK24 and LUU-1/B flare delivery wind correction chart with 25 s to obtain a wind correction factor of 42 ft/kt. Since the MK24 Mod 2 will drift 250 ft per knot of wind, for a 10-knot tailwind and a 5-knot crosswind the flare will drift 2500 ft downrange and 1250 ft to the side of the target area.

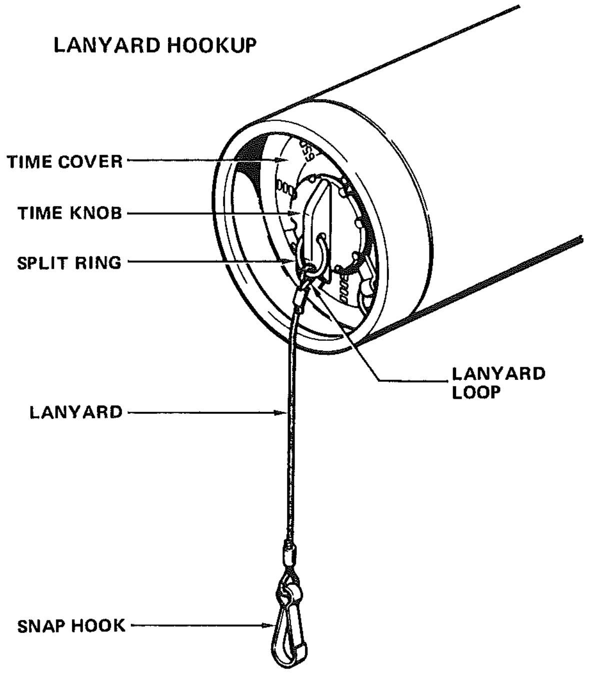
Therefore, it is desirable to ignite the flare 1250 ft uprange (one half the distance the flare will drift while burning) and 625 ft to the side of the target area. Before ignition the flare will drift 504 ft downrange and 336 ft across. Therefore, it is desirable to ignite the flare 1250 ft uprange (one half the distance the flare will drift while burning) and 625 ft to the side of the target area. Before ignition the flare will drift 504 ft downrange and 336 ft across. Therefore, to place the flare at ignition 1250 ft uprange and 625 ft to the side, the flare must be released 4124 ft uprange (2370 + 2150 + 504) and 961 ft (625 + 336) to the side of the target area.

LUU-2B FLARE

USED WITH BOMB/FLARE DISPENSER 11B29-003



MASS	13.6 kg (30 lb)
DIAMETER	124 mm (4.87 in.)
LENGTH	914 mm (36 in.)
FLARE DURATION	270 s
LIGHT OUTPUT RATING	2 Million Candelpower



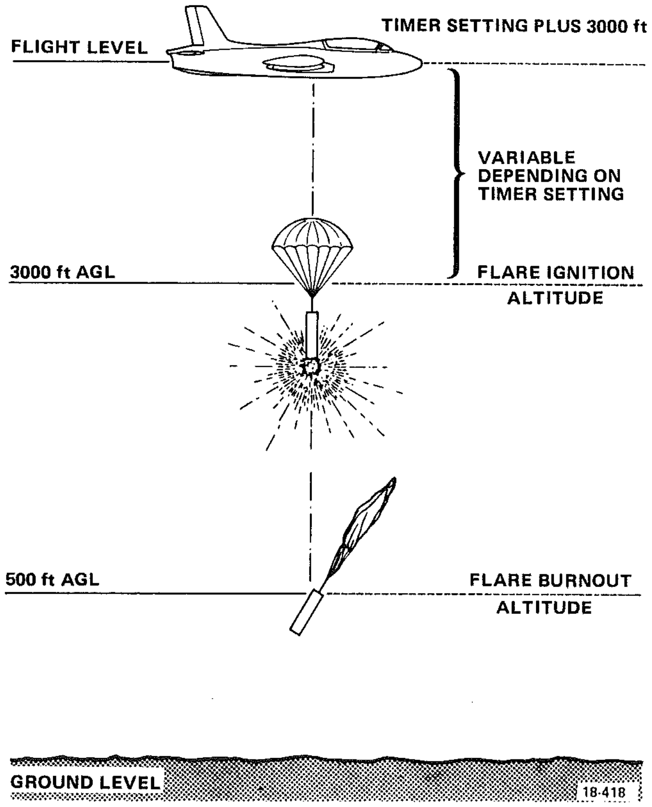


Figure 1-65.

LUU-2/B FLARE (fig. 1-65)

The LUU-2/B flare is a pyrotechnic illuminating device with a 4.5 min burn time. The flare weights approximately 30 lb and is identical to the MK-24 flare in external dimensions. Prior to placing the flare into the launcher, the desired free fall distance in feet (delay time) must be set into the timer. This is done by turning the knob in the center of the timer cover clockwise until the pointer is opposite the number of feet desired. The available settings are indicated in figure 1-64. The timer knob will be removed by the launcher as the flare is ejected through the launcher. Removal of the timer cover pulls the timer knob which starts the timer. After the selected delay time, the release mechanism is tripped allowing the timer and cover to be ejected from the flare case by a spring. As the timer is ejected, it pulls the parachute with it. Deployment of the main parachute produces the shock force on the support cables through the ignition lanyard to rotate a bellcrank in the ignition system, shearing a safety pin and cocking and releasing a firing pin. The firing pin strikes and initiates a primer which ignites boron pellets. The boron pellets ignite a wafer of propellent which ignites the flare candle. Pressure buildup on flare ignition blows out pressure relief plugs in the igniter housing after which the flare case burns through and the ignition housing falls free. The flare burns for approximately 270 s. At candle burnout, an explosive bolt is initiated which releases one parachute support cable causing the parachute to collapse.

PART 6 - MUNITION FUZES

BOMB FUZES

WARNING

Improper employment of a weapon fuze combination may result in serious damage to the aircraft or injury to the aircrew.

For bomb/fuze compatibility refer to figure 1-66.

A fuze is a device used to initiate bomb detonation at a predermined time and under the desired circumstances. Since targets are usually selected in advance of a mission and the structure of the target indicates the type of fuzing which would produce the best results, it is imperative that the correct fuzing system be installed in the weapon. Additionally, many weapons can accommodate a large variety of fuzes which can drastically change the weapon effects. Pilots must be familiar with the classification and operation of fuzes to effectively plan the mode of delivery and ensure safe escape from the contemplated weapon effects.

BOMB/FUZE COMPATIBILITY CHART

FUZE	TYPE		FUNCTIONAL DELAY	BOMBS	ARMING (AIR TRAVEL) DELAY
	NOSE	TAIL			
M904E1 M904E2 M904E3	X X X		Selective with delay elements M9, instantaneous, 0.01, 0.025 0.05, 0.10 and 0.25 s. delay.	MK 81 MK 82 MK 82/M1A1	904E1: Selective delay times of 4, 6, 8, 12, 12, 16, and 20 s. 904E2 and 904E3: Selective delay times of 2, 4, 6, 8, 10, 12, 14, 16, and 18 s. MK 82 (Snakeye I) compatible with M904E2 and M904E3.
M905		X	Selective with delay elements M9, instantaneous, 0.01, 0.025 0.05, 0.10 and 0.25 s. delay.	MK 81 MK 82	Selective delay time of 4, 6, 8, 12, 16 and 20 s.
FMU-26A/B FMU-26B/B	X	X	Airburst occurs 0.1 s. after arming	MK 81 MK 82	Airburst-Selectable 1.9 to 99.9. s. in 0.5-second increments (± 0.3 s. tolerance).

Figure 1-66 (Sheet 1)

BOMBE/FUZE COMPATIBILITY CHART

FUZE	TYPE		FUNCTIONAL DELAY	BOMBS	ARMING (AIR TRAVEL) DELAY
	NOSE	TAIL			
FMU-81/B	X	X	Impact-selay; selectable, .00, .01, .02 .05, .10,.25 s.	MK 81 MK 82	Impact short delay; selectable, non-delay 0.01, 0.02, 0.05, 0.10, 0.25 s. Impact short delay - Selectable 2.0 to 20.0 s. in 2.0-second increments (± 10% or 0.002 whichever is greater tolerance). Impact medium delay (FMU-26A/B only); selectable 6.0, 10.0, 12.0, 16.0, 20.0 s. Impact medium delay - Fixed 1.0 s. after release (± 0.25-second tolerance). Arming-delay selectable 4, 5, 6, 7, 8, 10, 12, 14 and 20 s.
FMU-72/B	X	X	Selectable in 20-minute increments from 20 min. to 5 h.; 1-hour increments from 5 to 16 h., 2-hour increments from 16 to 30 h.: 3-hour increments from 30 to 36 h.	MK 81 MK 82	Arming time 6 s. with tolerance of + 1.5 to - 1.0 s.

Figure 1-66. (Sheet 2)

CLASSIFICATION OF BOMB FUZES

Bombs fuzes may be separated into two general classifications: position (in the bomb) and function (fig. 1-67).
Position: Formerly, some bomb fuzes were installed transversely, but at present they are installed in the nose and/or tail of the bomb. Nose and tail fuzes usually are not interchangeable because of the differences in arming devices and internal operation. Some fuzes, such as the M173 bomb igniter fuze, arm by falling with either end of the bomb toward the direction of fall, and function at any angle of impact. This type can be used in either the bomb nose or tail.

Function: Fuzes are also classified according to the method of detonation. This action may result from:

a. Impact - Impact of the fuze with the target.

b. Proximity - Nearest to the target.

c. Time - A predetermined number of seconds after release.

d. Hydrostatic - Water pressure.

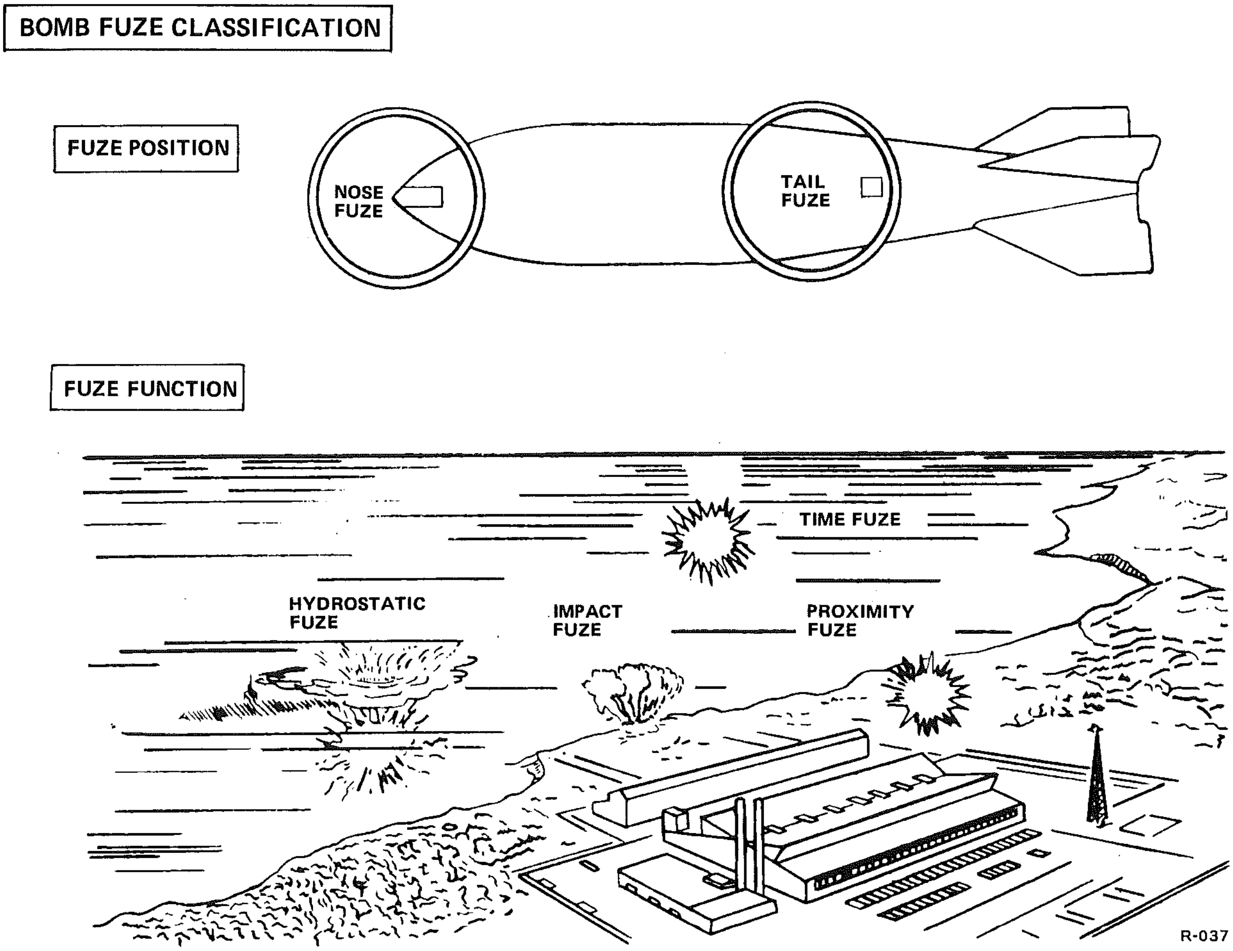


Figure 1-67.

METHODS OF ARMING

Fuzes are armed in one, or a combination, of four methods:

a. Vane - The arming-vane type fuze has a vane (propeller or anemometer), which is rotated after release, by air flowing past the falling bomb. When the vane has rotated the required number of times, the fuze is armed.

b. Pin - The arming-pin type fuze has a pin or plunger, which is ejected or withdrawn by spring action, when the bomb is release. The ejection of the pin releases the arming mechanism and allows the fuze to arm.

c. Inertia - The inertia-arming type fuze is armed by an abrupt change in the velocity of the following bomb (such as impact).

d. Electric - The electric-arming type fuze is armed by a thermal battery, which is activated at bomb release, by the extraction of an arming lanyard.

Arming Time Interval

Both arming-pin and arming-vane type fuzes are further classified according to the arming time interval; either direct-arming or delayed-arming.

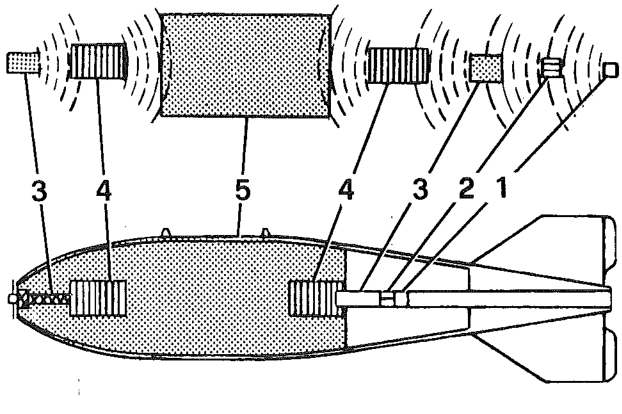
a. Direct-arming - A direct-arming fuze is armed immediately when the arming pin is ejected or when the arming vane has rotated the required number of revolutions.

b. Delayed-arming - The delayed-arming fuze has an arming pin or arming vane operating as in the direct-arming fuze. However, instead of arming the fuze directly, the mechanism, controlled by the pin or vane, initiates a powder train or cockwork mechanism, which arms the fuze after a predeterminated time has elapsed.

EXPLOSIVE TRAIN

An explosive train (figure 1-68) controls the functioning of an item of ammunition. Such a train is a sequence of explosions in which a small quantity of a very sensitive explosive ultimately sets off a larger quantity of much less sensitive explosive. The two basic explosive trains are the propelling charge (discussed under ammunition) and the bursting charge, as contained in bombs. The type of explosive use in such large quantities as in loading of bombs must be relatively insentitive to shock and heat. This is necessary for a number of reasons. It provides a reasonable degree of safety in storing; shipping and handling, allows the bomb to be dropped safe over friendly territory, and permits the bomb to be used to penetrate a resistant target such as armor plate, thick earth, or concrete before exploding. On the other hand, the type of explosive used in the fuze must be very sensitive so that it will be sure to explode when impacted by the firing pin. Such an explosive is not safe to handle, except in minute quantities, and therefore, is strongly compressed into a metal capsule, which is called a detonator and is built into fuzes. The shock, generated by the explosion of a detonator, is not sufficiently strong to be reliable as a means of exploding the large amounts of insensitive explosive that makes up the main charge of the bomb, so a small quantity of explosive, which is more sensitive than the main charge, is placed next to the detonator. This element is called the booster. The booster is sensitive enough to be exploded by the detonator and large enough so that the shock of its explosion will explode the bursting charge of the bomb. Such an arrangement of elements is called the explosive train, and is the basic method of operation in all explosive ammunition.

FUZE EXPLOSIVE TRAIN



1. PRIMER
2. DELAY
3. DETONATOR
4. BOOSTER
5. BURSTING CHARGE

Figure 1-68.

TYPES OF EXPLOSIVE TRAINS

The explosive train operation, in both nose and tail fuzes, may be instantaneous or delayed action.

a. Instantaneous - Instantaneous operation begins immediately upon weapon impact with the target when the firing pin is driven into the detonator (approximately the size of an aspirin tablet). The blast from the detonator explodes the booster (about the size of a standard flashlight battery), which relays and amplifies the blast, causing the bursting charge to explode.

b. Delayed action - A delayed action train may be necessary to allow bomb penetration of target or to permit a low-flying aircraft, which carried the bomb, to escape from the target area. This action requires two additional components, a primer and a delay element, which are placed ahead of a detonator, booster, and main charge. In this arrangement, the action starts off as a detonation, but it is converted into a delaying flame by the delay element. The detonator again changes it into a detonation which coontinues through the booster into the main charge.

ARMING WIRE INSTALLATION (TYPICAL)

Before the bomb is loaded, on the pylon arming wire are attached to the bomb suspension lugs. The other end is then inserted through the arming wire swivel loop and then through the front suspension lug. The tail fuze arming wire is attached to the right side of the front suspension lug. The other end is then inserted through the arming wire swivel loop and then through the aft suspension lug (figure 1-69). Respective arming wire swivel loops are inserted into the pylon nose-arming and tail-arming solenoids near the center of the bomb rack. The free ends of the arming wires are then attached ,or threated through safety devices in the fuze, thus maintaining the fuze in a

BOMB ARMING WIRE INSTALLATION (TYPICAL)

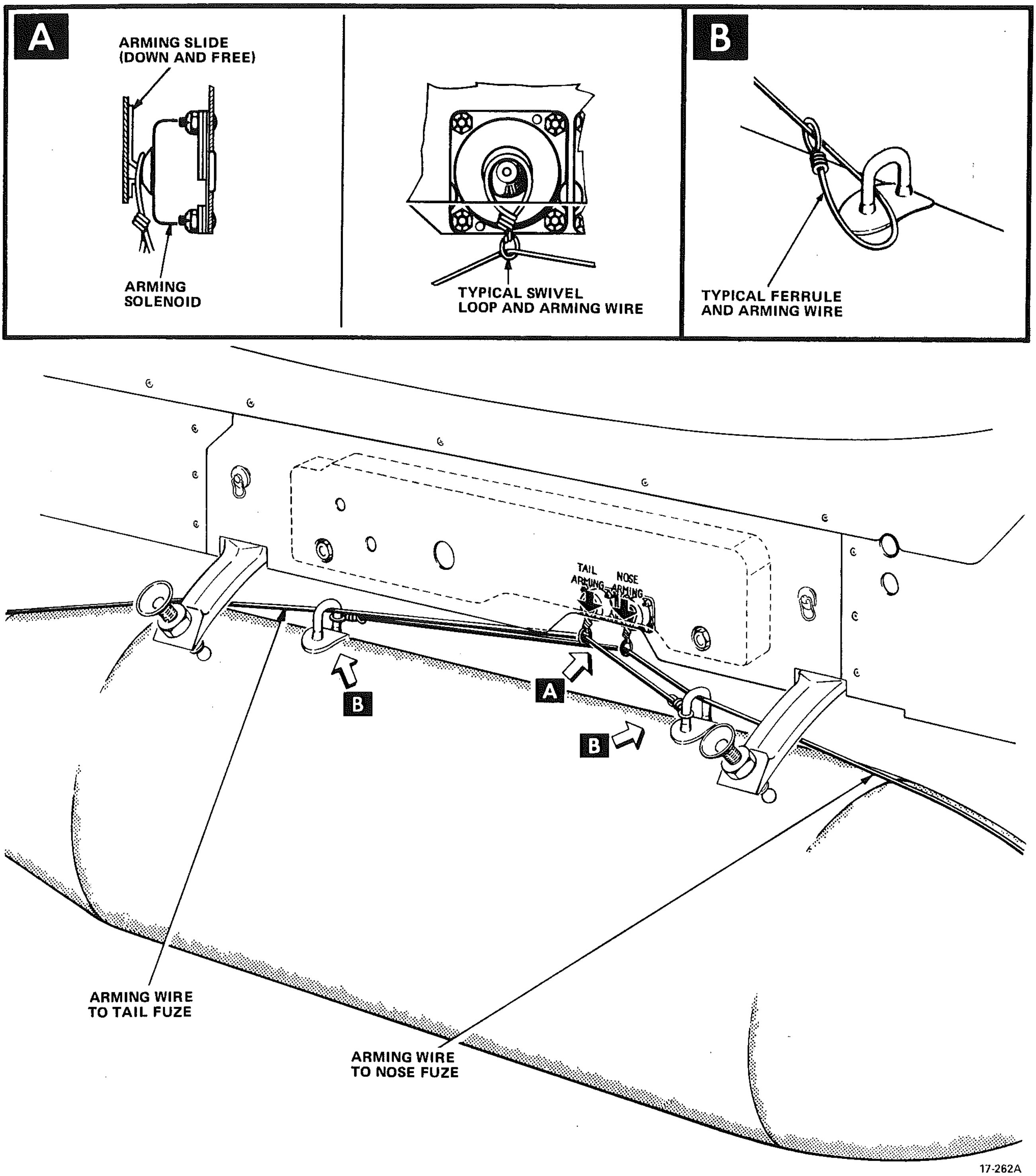


Figure 1-69.

safe (unarmed) condition. Fahnestock clips are placed over the ends of the arming wires to tightly grip the wire and act as a safety device that prevents extraction of the arming wire by loads that are much less than the load applied by the bomb at release.

SAFETY FEATURES

For safety reasons, a bomb must be incapable of exploding through fuze action before it is clear of the aircraft. By definition, a fuze is armed when the next normally expected event will initiate a function of the fuze. As previously discussed, that event may be impact, time train running to completion, nearness to the target, or water pressure. As shipped, fuzes are in a safe (unarmed) condition. They are so constructed that while unarmed they cannot function. To prevent premature or accidental functioning of the fuze, a safety feature is incorporated when it is manufactured. The most common safety feature in fuzes are detonator-safe arming-stem-safe, and safety-block-safe-devices (figure 1-70).

Detonator-Safe

A detonator-safe arrangement, commonly found in nose fuzes, holds one of the explosive train elements out of alignement with the other elements. For example, the detonator may be held out of line with the firing pin until the fuze is armed.

Arming-Stem-Safe

A safety feature, commonly found in tail fuzes, is an arming stem which is screwed into the firing pin plunger. In this type of fuze, the detonator is located immediately blow the firing pin. Arming of the fuze withdraws the arming stem from the firing pin plunger, thus freeing the plunger. An anti-creep spring prevents premature movement of the plunger.

Safety-Block-Safe

This safety feature, commonly found in nose fuzes, consists of a ring of small steel blocks that are located between the striker and the fuze body, thus preventing the firing pin from contacting the primer or detonator. The arming vane drives a gear train which, after a definitive interval, permits the safety blocks to be ejected.

MUNITION FUZES

A munition fuze is a device for initiating the explosive train of a bomb at the appropriate time to fulfill the mission requirements. Normally fuzes are placed in both the nose and tail of a bomb to increase functioning reliability.

M904E1, M904E2 AND M904E3 NOSE FUZES

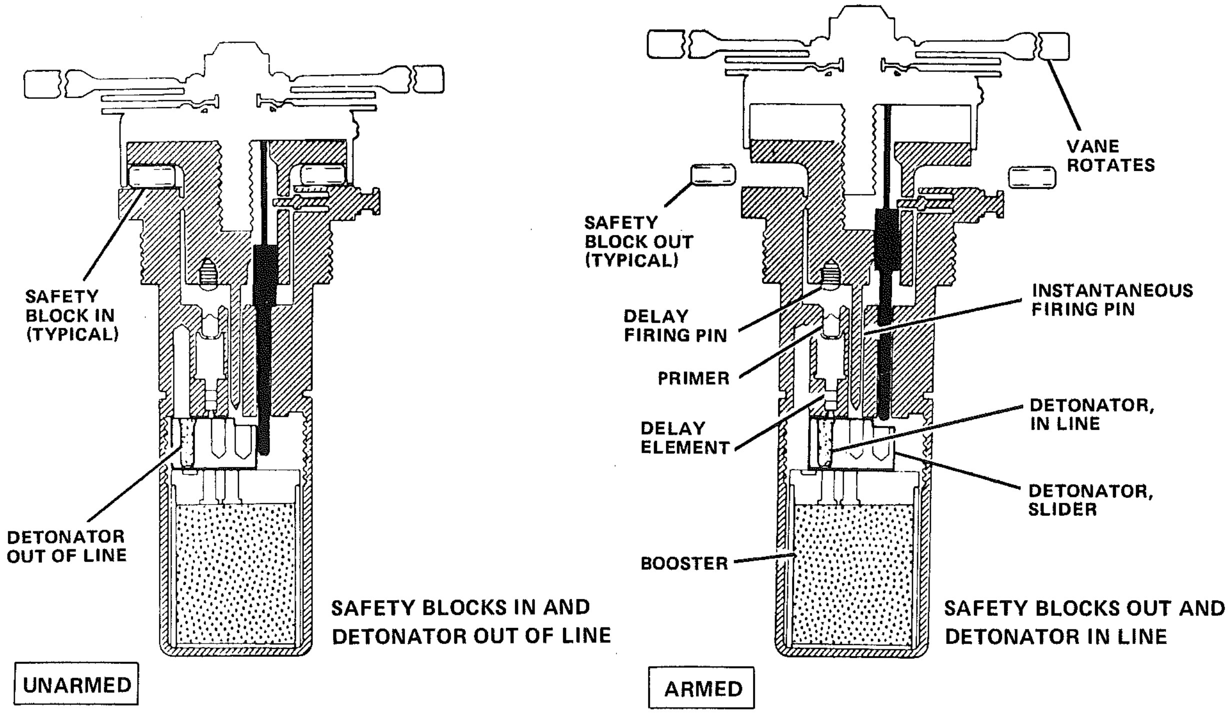
The M904 nose fuze (figure 1-71 and 1-72) is a mechanical impact nose fuze, commonly used with general purpose bombs. It is approximately 9.33 inches long by 2 inches in diameter at the fuze threads. The desired arming time for the M904E1 fuze is set on a calibrated dial, with selective delay times of 4, 6, 8, 12, 16 and 20 seconds. The M904E2 and M904E3 fuze calibrated selective delay times are 2, 4, 6, 8, 10, 12, 14, 16 and 18 seconds. The M904 fuze employs an arming vane to effect arming. The arming time is independent of release airspeed and is accomplished by the nose vane, a mechanical governor, and a constant-speed rotating gear train. Impact functioning (detonation) delay times are provided by inserting a delay element (M9) in the cavity just beyond the firing pin. The delay elements are available in the following delay increments: instantaneous, 0.01, 0.025, 0.05, 0.10 and 0.25 second. Safety features include a rotor containing the detonator, which is locked out of line with the rest of the explosive train until trajectory arming is completed. The fuze has two warning windows. One window is located in the fuze body and one is just above the booster. If the M904E1 or M904E2 fuze should accidentally become armed, the arming window in the body will show a red flag. If the M904E3 fuze should accidentally become armed, the arming window in the body will show a black A on a red background. The other window, above the booster, is not visible to the aircrew.

WARNING

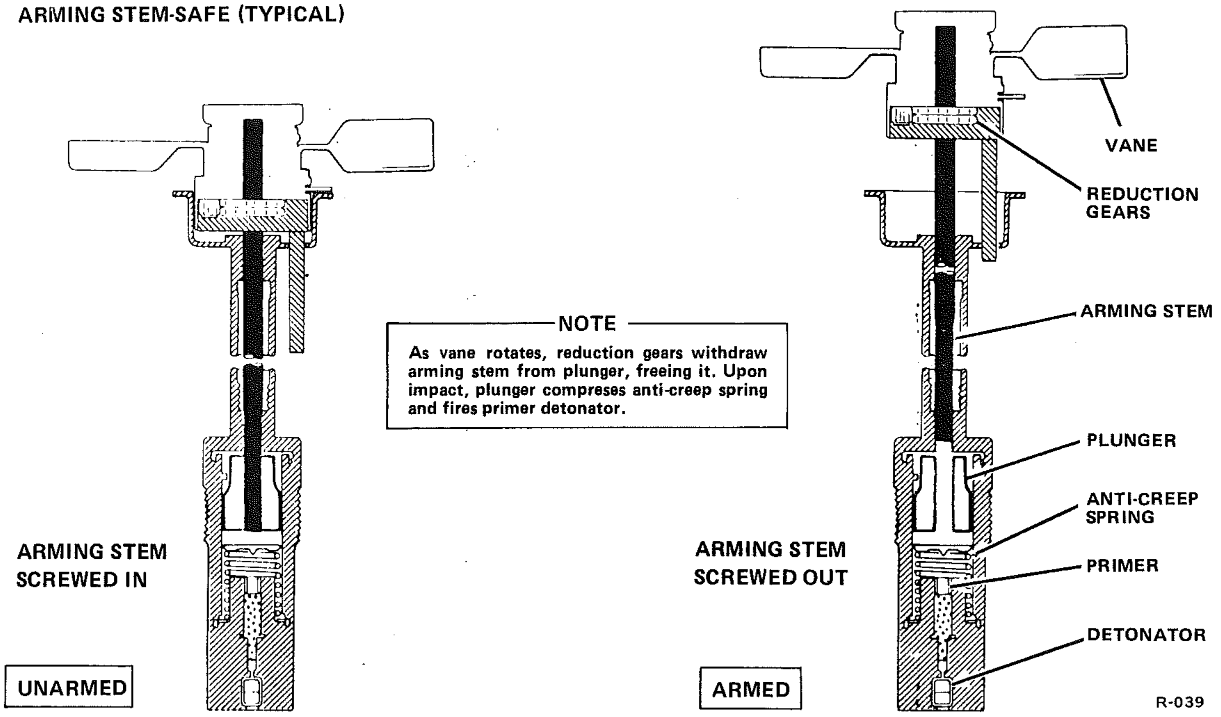
If the window in the M904E2 fuze body shows a red, or the window in the M904E2 fuze body shows a black A on a red background, the fuze in unsafe and should not be touched. Call explosive ordnance disposal (EOD) personnel immediately.

BOMB FUZE SAFETY FEATURES

SAFETY BLOCK-SAFE AND DETONATOR-SAFE (TYPICAL)



ARMING STEM-SAFE (TYPICAL)



NOTE

As vane rotates, reduction gears withdraw arming stem from plunger, freeing it. Upon impact, plunger compresses anti-creep spring and fires primer detonator.

Figure 1-70.

M904 NOSE FUZE

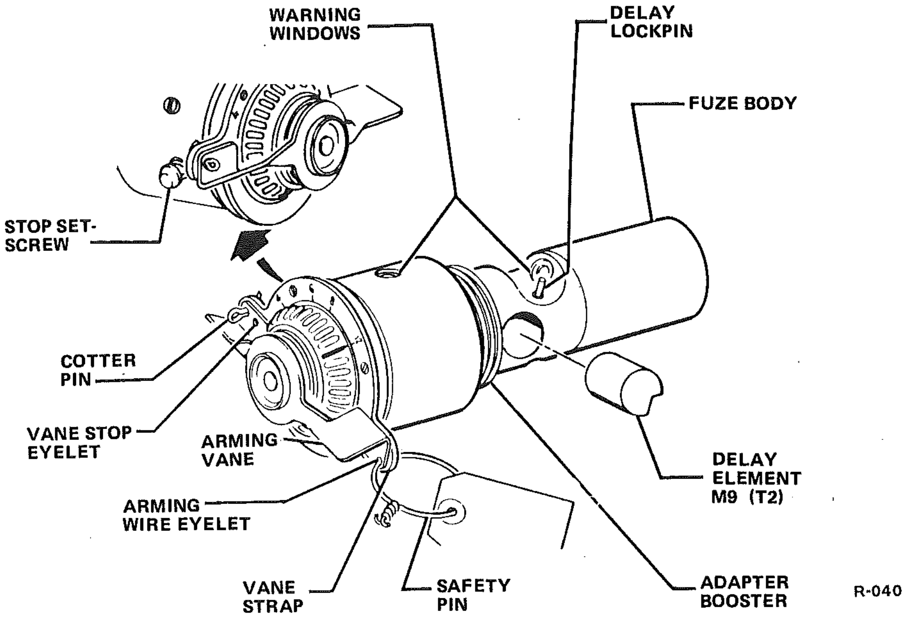


Figure 1-71.

Fuze arming begins when the bomb is released from the aircraft. The arming wire is withdrawn from the vane and the vane spins in the airstream (operating range is 150 to 600 kt).

After the selected arming time has elapsed, the spring-loaded rotor is permitted to rotate and align the detonator with the rest of the explosive train. The rotor is locked in position and the fuze assembly moves rearward causing the firing pin to strike the detonator, which in turn initiates the explosive train.

CAUTION

The M904E1 fuze has a manufactured arming time tolerance of ± 20 percent; the M904E2 and M904E3 tolerance is ± 10 percent. The negative tolerance of the fuze must be used when determining the minimum arming separation between weapon and aircraft. The positive tolerance must be used to determine the minimum release altitude to insure fuze arming before impact.

M905 TAIL FUZE

The M905 tail fuze (figure 1-73) is a mechanical impact tail fuze commonly used with general purpose bombs. It is approximately

M1A1 FUZE EXTENSION WITH M904 FUZE

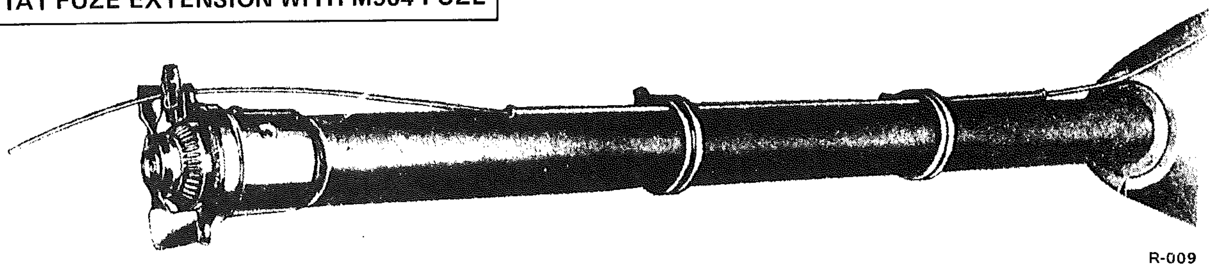


Figure 1-72.

M905 TAIL FUZE

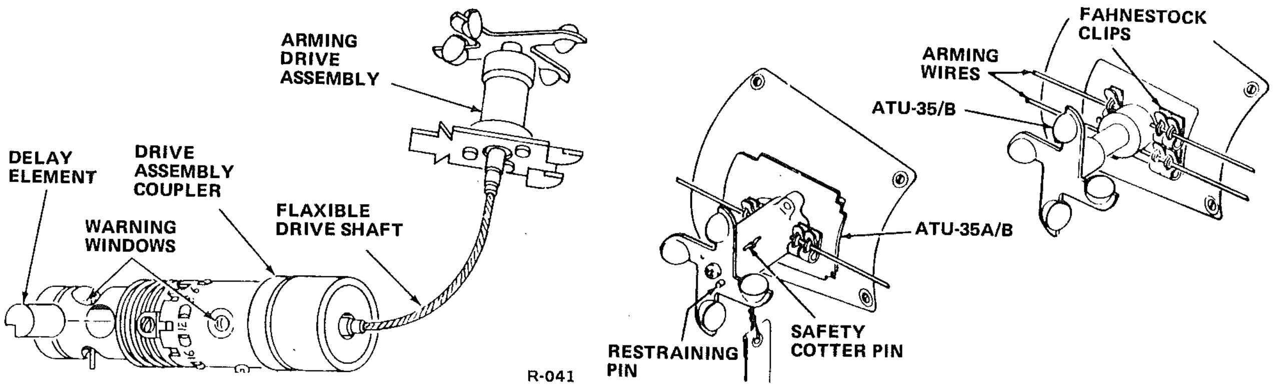


Figure 1-73.

6-1/8-inch long and 2-inch in diameter at the fuze thread. Arming is effected by either the ATU-35/B or the ATU-35A/B arming drive assembly through a MAU-86/B flexible drive shaft, instead of by an arming vane. Arming time is independent of release airspeed and is accomplished by the arming drive assembly, flixible shaft, mechanical governor, and constant-speed rotating gear train. The desired arming time is set on a calibrated dial, with selective delay times of 4, 6, 8, 12, 16 and 20 seconds.

Impact functoning (detonation) delay times are provided by inserting a delay element (M9) in the cavity just beyond the firing pin. The delay elements are available in the following delay increments: instantaneous, 0.01, 0.025, 0.05, 0.10 and 0.25 second. Safety features include a rotor containing the detonator, which is locked out of line with the rest of the explosive train until air arming is complete, and two warning windows. One window is in the fuze body and one is just above the booster. If the fuze should accidentally become armed, the warning window in the body will show a red flag. The other window, above the booster, is not visible to the pilot.

WARNING

If the window in the fuze body shows full red, the fuze is unsafe and should not be touched. Call explosive ordnance disposal (EOD) personnel immediately. This fuze must not be used for skip-bombing operations.

Fuze arming starts when bomb is released from the aircraft and the arming wire is withdrawn from the vane tab or the arming drive assembly. This permits the vane tab to rotate the inner parts of the fuze (operating range of the fuze is 150 to 600 kt). After the selected arming time has expired, the firing pin is free to move in the direction of flight, upon sufficient deceleration of the fuze. An anti-creep spring prevents premature movement of the firing pin due to velocity changes of the bomb, during free fall. At approximately the same time that the firing pin arms, the rotor containing the detonator is released so that it may rotate by spring action, bringing the detonator in line with the rest of the explosive train. A detent locks the rotor in the armed position, and the fuze is then armed. When the bomb impacts on target, the inertia generated by the bomb causes the firing pin assembly to move forward and strike the primer in the delay element, thus initiating the explosive train.

CAUTION

The M905 fuze has a manufactured arming time tolerance of ± 20 percent. The negative tolerance of the fuze must be used when determining the minimum arming separation between weapon and aircraft. The positive tolerance must be used to determine the minimum release altitude to insure arming before impact.

FMU-26A/B AND FMU-26/B NOSE OR TAIL FUZE

The FMU-26A/B and FMU-26B/B fuzes (figure 1-74) are electric fuzes, powered by internal thermal batteries. They can be used as nose or tail fuzes and will provide air-burst or impact-initiated burst. The air burst mode is intended for use only with dispenser type munitions. These fuzes are cylindrically shaped, approximately 3-inch in diameter and 6.5-inch in length. They are compatible with bombs that have internal plumbing (required to route the arming lanyard) and standard 3-inch fuze wells (nose and tail) which include MK 81 and MK 82 GP bombs.

The arming lanyard (figure 1-75) is routed from the charging well of the bomb, to a battery firing device, which is attached to the fuze in the nose or tail fuze well. In the case of the FMU-26A/B fuze, the free end of the arming lanyard, which is protruding from the charging well of the bomb, is routed through a swivel loop and then into a lanyard lock, which is installed in the charging well, and secured by a lanyard lock nut. When the bomb is loaded on the bomb rack, the swivel loop is installed in the bomb rack arming solenoid. In the case of the FMU-26B/B fuze, the initiation system may be the same as above, or it may be as follows:

The free end of the arming lanyard, which is protruding from the charging well of the bomb, is routed through a lanyard length adjustment device. The excess lanyard is then cut off. When the bomb is loaded on the bomb rack, the pull ring of the lanyard length adjustment device is installed in the bomb rack arming solenoid.

When a bomb containing an FMU-26A/B fuze is released armed, the arming solenoid holds the swivel loop, which remains with the bomb rack, as the arming lanyard is withdrawn through the swivel loop. The arming lanyard remains attached to the bomb by the lanyard lock. This action cocks and releases the firing pin, which initiates the thermal battery in the fuze. When a bomb containing an FMU-26B/B fuze is released armed, the initiation system may function as above, or it may function as follows: The arming solenoid holds the pull ring of the lanyard length adjustment device, thus pulling the lanyard. This pull cocks and releases the firing pin which initiates the thermal battery in the fuze. Then a shear pin breaks, separating the lanyard length adjustement device from its pull ring. The pull ring remains with the solenoid; the lanyard remains attached to the fuze battery firing device.

The thermal battery provides the electrical power for fuze operation. The fuze timing circuitry provides an arming signal at the preset arming time. This arming signal is used to arm the fuze; that is, to rotate the detonator from the out-of-line position to the in-line or firing position. The fuze timing circuitry then provides the firing (final event) signal at the preset time for impact or airburst function. The fuze modes, with the available arming times and final event times, are tabulated in figure 1-76.

NOTE

> The arming time tolerance for the short delay mode is ± 0.3 s. With this mode, the minimum allowable bomb time of flight (to prevent duds) will be the arming setting plus 0.3 s.

The event and arm times are set into the fuze with an allen wrench and are displayed in the windows on the fuze. The safe pin locks the fuze rotor in the out-of-line position until after the fuze is installed in the bomb. Prior to departure of the loaded aircraft from the loading area, the safe pin is removed from the fuze and replaced with the seal pin. The seal pin prevents entry of moisture into the fuze.

The aft end of the fuze (the booster end) has a pie-shaped section to accept a booster. Two kinds of booster are used: a 45 g RDX booster, which is secured to the fuze by tape, and a 5 g M-5 propellant booster (FZU-1/B booster), which is secured to the fuze by a metal bracket.

The bracket is also used to activate the air-burst mode. The aft end of the fuze also has a safe plug and a safety switch. The safe plug is only in the fuze during shipping and handling, and is removed prior to installation of the fuze into the bomb. The battery firing device is installed in the cavity vocated by the safe plug.

When the FMU-26A/B fuze is used in high explosive bombs, the 45 g RDX booster (booster and tape assembly) is used.

The FMU-26A/B; -26B/B fuze safety switch has three positions: RED, GREEN (normal), and BLUE (airburst). The GREEN (normal) position keeps the firing circuit to the detonator disabled for apporximately 6.6 s. after bomb release.

FMU-26A/B AND FMU-26B/B FUZES

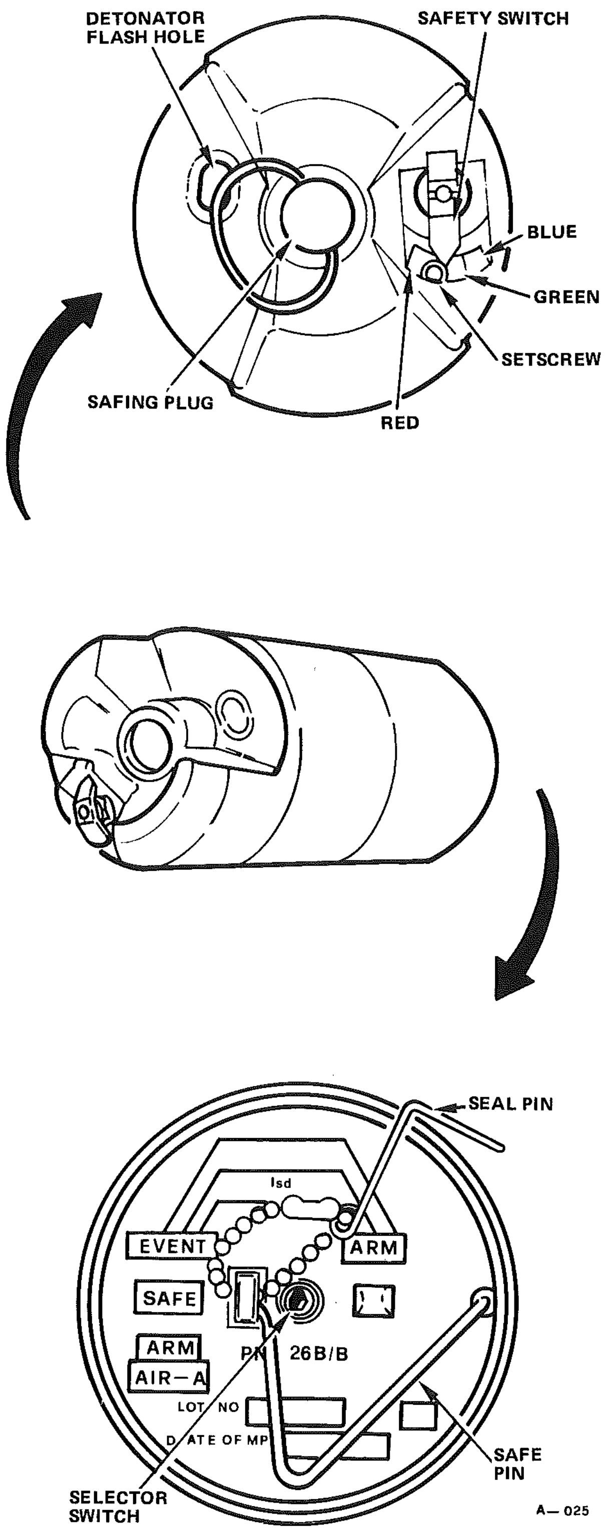


Figure 1-74.

FMU-26 SERIES FUZES ARMING WIRE

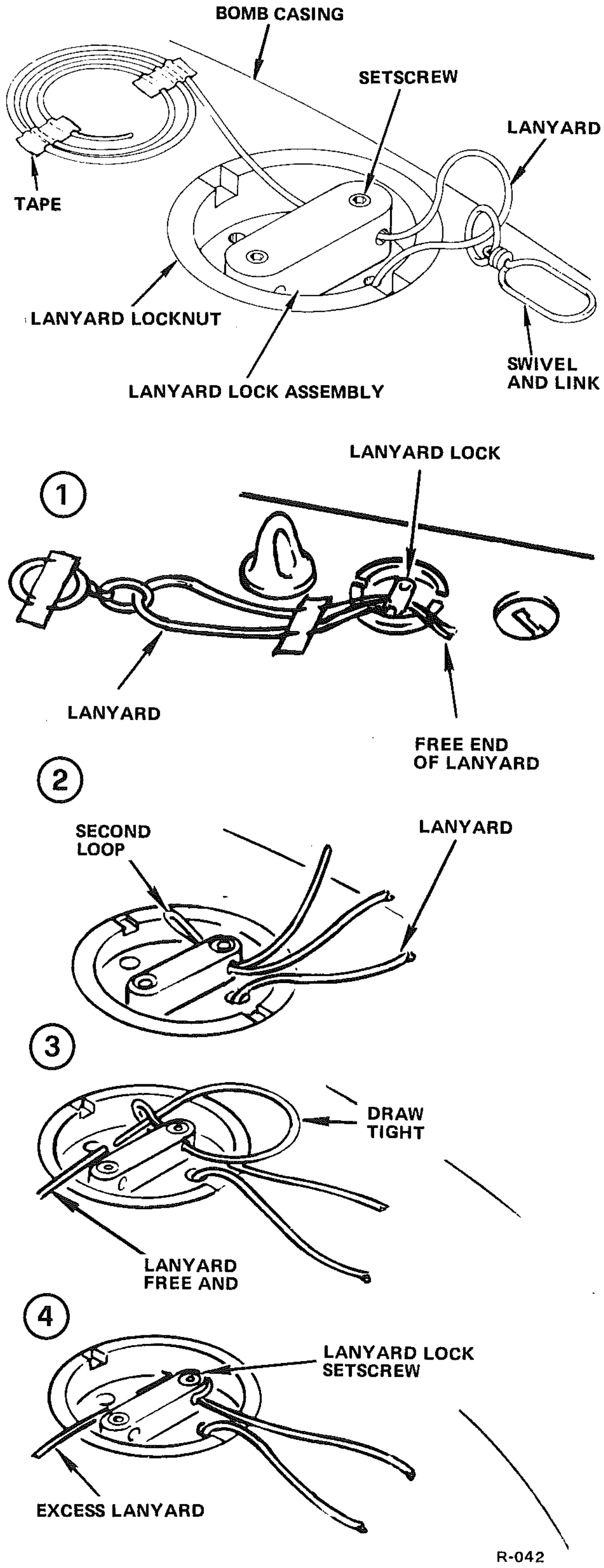


Figure 1-75.

NOTE

> The fuze contains a safing device which duds the fuze if impact occurs prior to arming.

The safety switch should be kept in the GREEN position for all medium delay (skip mode) settings. It should also be kept in the GREEN position for all short delay (dive mode) settings, except when operational delivery conditions are such that the time from bomb release to impact will be less than 6.6 s. For releases where time is less than 6.6 s., the safety switch must be set in the RED position to assure fuze function at the preset time. The BLUE position can be selectrd only when the FZU-1/B (airburst) booster is installed. The FZU-1/B booster has a metal bracket which holds the spring-loaded safety switch in the BLUE position. When the FZU-1/B booster and its bracket are removed, the safety switch will spring to the GREEN position. The airburst mode is inoperative when the safety switch is not in the BLUE position. If the fuze selector switch is set in the airburst mode, but the safety switch is not set in the BLUE position, the fuze will not detonate airburst, but will detonate on impact through the back up circuit.

CAUTION

> Whether the FMU-26A/V, -26B/B fuze is set in the RED position or the GREEN position, the minimum release altitude, or vertical drop required for safe escape, must be carefully observed as specified in the appropriate minumum release altitude/fuze arming time tables.

The fuze can be used more advantageously in the nose well. Nose installation permits easier access for inspection by the aircrew and for changes of arming and event time settings if such changes are required after initial loading. The inspection and changes can be done if the nose plug is removed. If the tail fuze well is used, the initial fuze settings are most easily accomplished before the fuze is installed in the bomb. After fuze installation settings are most easily accomplished with the bomb tail fin removed. Changes in tail fuze settings require removal of the fuze from the bomb, or removal of the tail fin and fuze nose plug. Further descriptive and procedural information is contained in T.O. 11A7 series.

FMU-72/B LONG-DELAY FUZE

The FMU-72/B (figure 1-77) is cylindrically shaped, approximately 3-inch in diameter by 6.5-inch in length. The FMU-72/B and its components are compatible with internal

FMU-26 SERIES ARMING TIMES AND MODES

FINAL EVENT TIME	EVENT TOLERANCE	MODE	ARMING TIME
Selectable. Occurs 0.1 s. after arming	± 0.3 s.	Airburst 1 (FMU-26A/B and FMU-26B/B only)	Selectable 1.9 to 99.9 s. in 0.5 s. increments
Selectable Non-Delay 0.010, 0.020, 0.050, 0.100 or 0.250 s.	± 10% or + 0.002 s. whichever is greater	Impact 2 Short Delay	Selectable 2.0 to 20.0 s. in 2.0 s. increments
Selectable 6.0, 10.0, 12.00, 16.0 or 20.0 s.	± 0.25 s.	Impact 3 Medium Delay (FMU-26A/B only)	Fixed 1.0 s. after release

Figure 1-76.

FMU-72/B LONG-DELAY FUZE

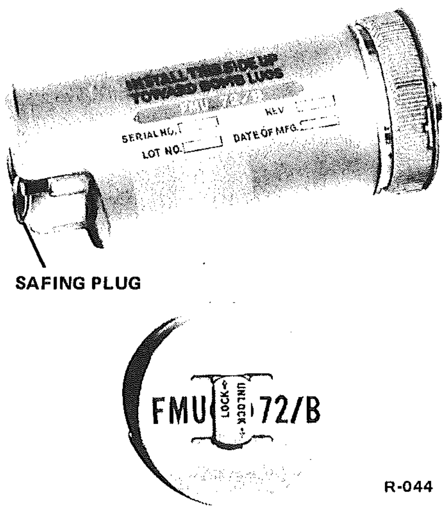


Figure 1-77.

plumbing and a standard 3-inch fuze well. Setting must be made prior to installing the fuze into the fuze well. If a change in a setting is required, after installing the fuze, it must be removed from the bomb to make the change. The FMU-72/B is compatible with the MK 81 Low Drag GP bombs.

CAUTION

> Since the fuze settings are not visible to the pilot for inspection, the munitions handling and loading personnel must be carefully briefed on required settings.

The FMU-72/B fuze is activated upom armed release. The swivel and link assembly is attached to the bomb and falls with the bomb. When the bomb is released, the lanyard is pulled. This pull (greater than 36 lb) cocks and releases the firing pin, which initiates the liquid ammonia battery in the fuze. The battery provides electrical power for fuze operation. The arming circuitry provides a fixed delay for the signal for arming. The arming signal is used to arm the fuze by rotating the detonator from the out-of-line position to the in-line or firing position. To assure that the detonator does not fire at arming, it is grounded until impact occurs, and the power source, which fires the detonator, is not charged until 33 s after impact. The fuze timing and counting circuitry provides the firing or final event signal at the set event time after impact. The arming time and selectable event times are listed below:

- Arming Time - 6.0 s with tolerances of + 1.5 to 1.0 s.
- Event Times - Selectable in 20 min increments from 20 min to 5 h; 1-hour increments from 5 h to 16 h; 2-hour increments from 16 h to 30 h; and 3-hour increments from 30 h to 36 h.

WARNING

> When the FMU-72/B fuze is used in general purpose bombs, select minimum release altitudes which will provide safe escape from bomb fragments for instantaneous or contact bursts. This is required to protect the aircraft and aircrew in the event of a premature bomb detonation at initial impact. To preclude ricochet, release conditions for general purpose bombs, should provide a trajectory angle at impact in excess of 40°.

NOTE

> To assure adequate time for the FMU-72/B fuze to arm prior to impact, use the minimum release altitudes as specified in the fuze arming time tables for the M904E2/M905 fuze with a 6 s arming delay setting.

The lanyard lock, installed in the bomb internal plumbing well (charging well) is held in place by the lanyard lock nut. The battery firing device (BFD) and lanyard assembly are installed in the nose or tail fuze well. The lanyard passes through the internal plumbing during installation. The BFD enters the plumbing, until the clips at the center of the BFD latch over the nut on the bomb plumbing. The swivel and link are placed on the lanyard prior to securing the free end of the lanyard lock. The key lanyard lock is used to secure the lanyard lock. The safe plug is in the fuze during shipping and handling and is removed just prior to installing the fuze in the bomb fuze well. The desired delay time must be set in the fuze prior to installing the fuze in the bomb. The fuze with attached booster is inserted into the fuze well and mates with the

BFD. Once the fuze is installed in the fuze well, the selected delay time is hidden from view. The fuze retainer fits against the fuze with two of the tabs in the spanner slots of the fuze well. The closure ring is used to hold the fuze in the fuze well. The nose plug is threaded into the closure ring. The fuze contains a safing switch, which duds the fuze in the event impact occurs prior to arming.

CAUTION

> Rough handling of the fuze after it is removed from the shipping container and especially during the installation when the safe plug is removed, could result in a dud fuze. The munitions handling and loading personnel must be cautioned not to mishandle the fuze or install a fuze which has been inadvertently dropped.

M 132, M 133 AND M 134 TAIL FUZES

All fuzes in this group have the same delay rating (see T.O. 11-1-28); they act to detonate the bomb 16 min after arming. These tail fuzes differ in overall length so that the same type of fuze can be used in various size bombs.

M 166E1, AN-M166 AND M 168 PROXIMITY FUZES

Proximity fuzes type M 166E1, AN-M 166, M 168 (see T.O. 11-1-28) are bar-type fuze which have transverse dipoles stengthened so that they can be used to screw the fuze into the bomb without a wrench. The arming vane of the fuze drives a high speed shaft and a low speed shaft. An electric generator is mounted on the high speed shaft which furnishes power to charge a firing capacitor and to operate the transmitting and receiving unit which controls the electronic switch between the firing capacitor and shaft by a spring loaded pin. The rotor controls both mechanical and electrical arming. When a material objet enters the zone of influence of the armed fuze, the reflected wave causes the firing switch to operate. Since these fuzes operate on any object, airborne minimum safe air travel (Min SAT) is carefully calibrated for the protection of friendly planes. Bar-type fuzes give average heights of burst of approximately 25 to 125 ft depending on size of bomb and nature of target; the performance is comparatively independent of altitude and speed of release.

MK4 PRACTICE BOMB SIGNAL

Practice bomb signal MK4 mods 3 and 4 (see T.O. 11-1-28) are essentially 10-gauge shotgun shells. They contain an expelling charge and are primed with a commercial primer. S pyrotechnic or inert marker is expelled when fired. The resulting flash and white smoke puff permit observation of bombing accuracy.

FRENCH DESIGNED BOMB FUZES

MATRA TYPE 19 NOSE FUZE

All GP bombs fitted with standard 2-inch liner can be fitted with the Matra type 19 universal nose fuze (figures 1-78 and 1-79). It can function by use of either setback or inertia forces and detonate either instantaneously upon impact or with delay action of approximately 15 seconds. Further explanations and instructions about the Matra type 19 fuze are available on Matra publication No. 61/UMAT/AR.

MATRA TYPE 20 TAIL FUZE (fig. 1-80)

This fuze, used with the Matra M14 FRC booster, is fitted into the tail device "COMBINE MATRA 200 A" (fig. 1-81) which controls both the drag parachute operation and the fuze arming of the MATRA-SAMP TYPE 25A bomb .
Further explanations and instructions are available on Matra publication No. 61/ /UMAT/AR.

BOMB FUZES, MISCELLANEA

AN-M103A1, AN-M139A1 AND AN-M140A1 NOSE FUZES

WARNING

> Nose fuzes of this type are vane-operated and delay-armed. Since are FAST ARMING fuzes should not be used on high-performance type aircraft.

MATRA TYPE 19 NOSE FUZE - INSTANT

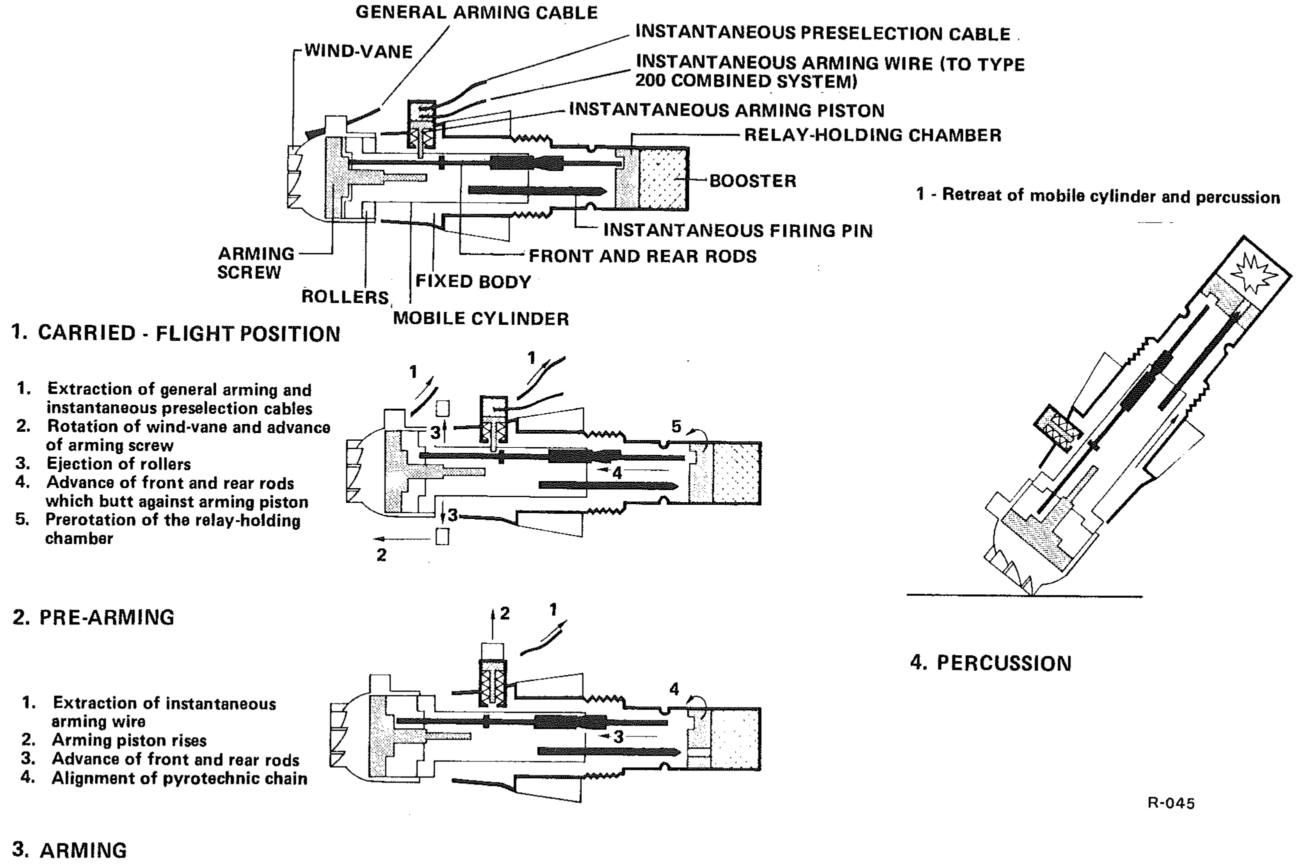

GENERAL ARMING CABLE
WIND-VANE
INSTANTANEOUS PRESELECTION CABLE
INSTANTANEOUS ARMING WIRE (TO TYPE 200 COMBINED SYSTEM)
INSTANTANEOUS ARMING PISTON
RELAY-HOLDING CHAMBER
BOOSTER
INSTANTANEOUS FIRING PIN
FRONT AND REAR RODS
ARMING SCREW
FIXED BODY
ROLLERS
MOBILE CYLINDER
1. CARRIED - FLIGHT POSITION
1. Extraction of general arming and instantaneous preselection cables
2. Rotation of wind-vane and advance of arming screw
3. Ejection of rollers
4. Advance of front and rear rods which butt against arming piston
5. Prerotation of the relay-holding chamber
2. PRE-ARMING
1. Extraction of instantaneous arming wire
2. Arming piston rises
3. Advance of front and rear rods
4. Alignment of pyrotechnic chain
3. ARMING
1 - Retreat of mobile cylinder and percussion
4. PERCUSSION
R-045

Figure 1-78.

M163, M164 AND M165 NOSE FUZES

Nose fuzes of this type are similar to AN-M103A1, AN-M139A1 and AN-M140A1 respectively, except for point of increased arming time (see T.O. 11-1-28). Further increase in arming time can be provided for fuze M163 by use of arming vane M3, which has its angle of vane surface twisted 75°.

MK243 MOD 0 AND MK244 MOD 1 NOSE FUZES

Water discriminating nose fuze MK243 Mod. 0 function after a 0.025-second delay, while nose fuze MK244 Mod. 1, which is not water discriminating, has a delay of 4 s. In case of direct hit, the impact with at least 1/4-inch steel plate or hard ground is necessary for detonation of MK243 Mod. 0 fuze. In case of near miss the tail fuze will detonate the bomb at an optimum penetration of about 25 ft to produce a mining effect (see T.O. 11-1-28).

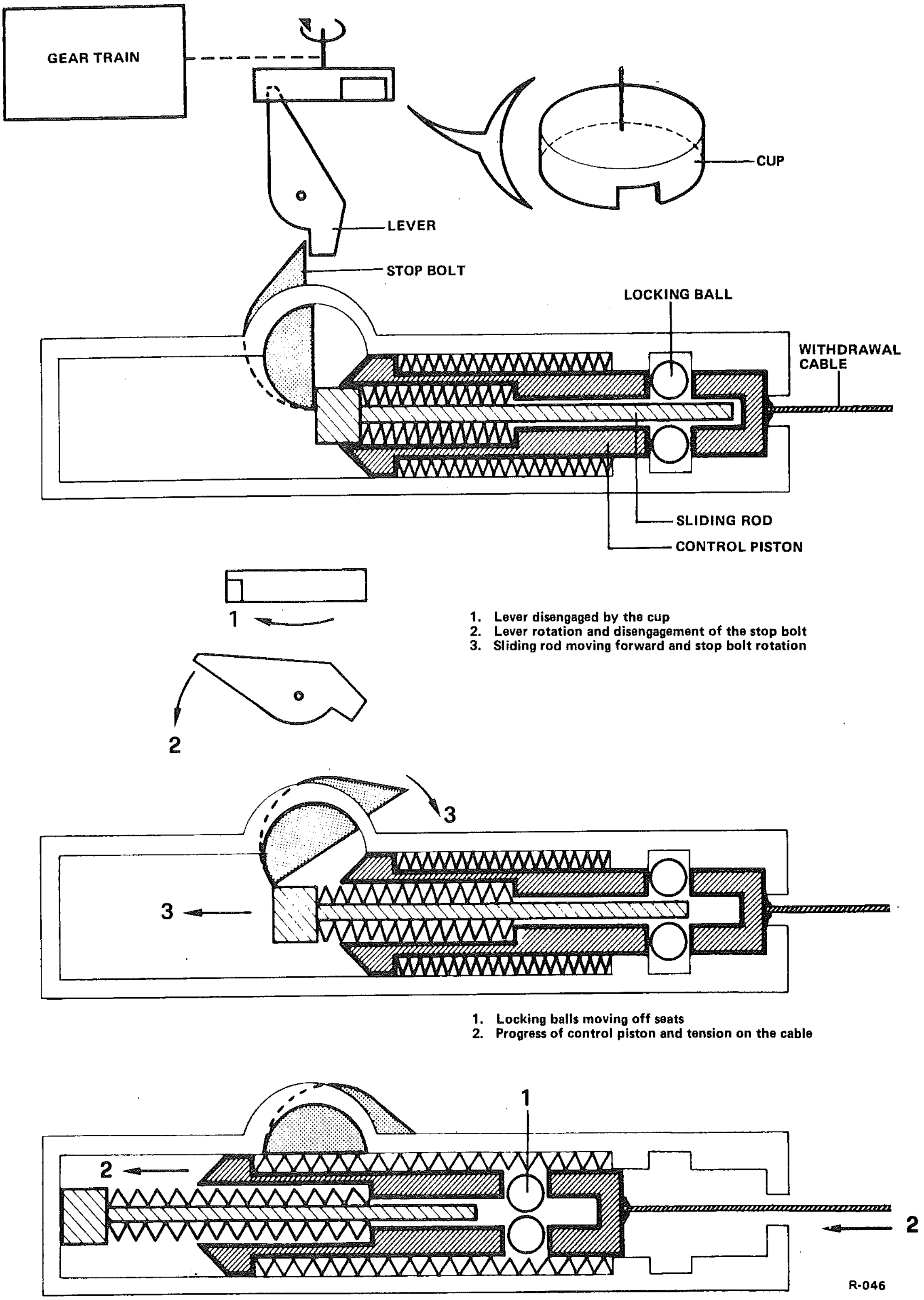
AN-M100A2, AN-M101A2, M160, M161, M172, M175 TAIL FUZES

Tail fuzes of this type are vane-armed and inertia-fired. Arming is mechanically delayed by reduction gearing. When issued the fuzes are equipped with either a non-delay or a 0.025-second delay primer detonator M 14, which can be interchanged with other primer detonators M14 to give a selection of time delay (see T.O. 11-1-28).

M112, M112A1, M113, M114 TAIL FUZES

These fuzes differ from the M115 series in that they do not have reduction gears in the vane assembly and therefore arm more quickly. The air travel to arm is 100 ft. The fuzes of this family are for use with box type fins and differ from each other only in length (see T.O. 11-1-28).

MATRA TYPE 19 NOSE FUZE - DELAY



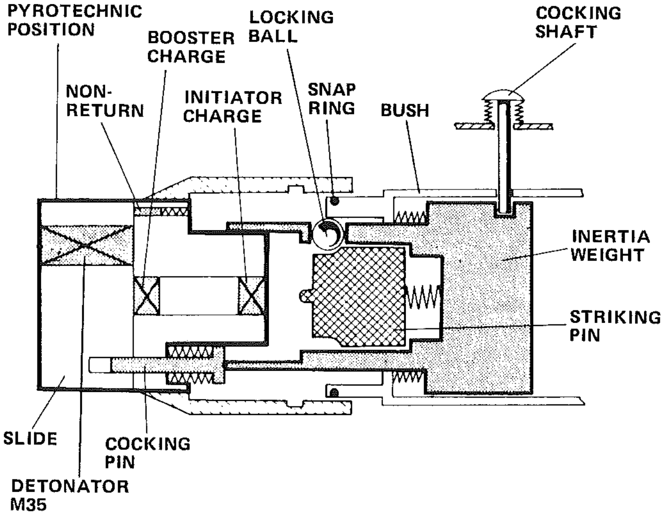
1. Lever disengaged by the cup
2. Lever rotation and disengagement of the stop bolt
3. Sliding rod moving forward and stop bolt rotation

1. Locking balls moving off seats
2. Progress of control piston and tension on the cable

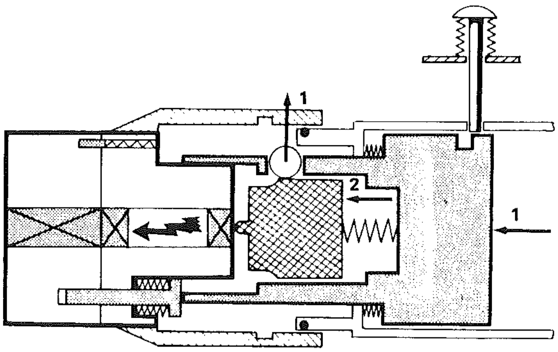
Figure 1-79.

MATRA TYPE 20 TAIL FUZE

1. REST POSITION

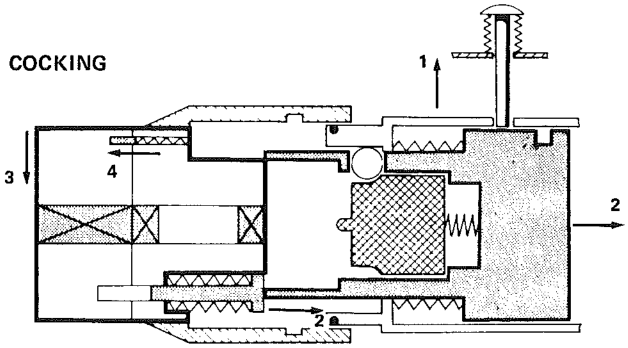


3. PERCUSSION



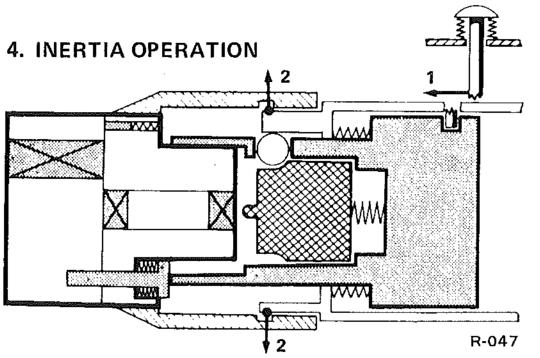
1. Inertia weight moving forward and disengagement of the locking balls
2. Striking and firing of pyrotechnic chain

2. COCKING



1. Retraction of cocking shaft
2. Inertia weight and arming shaft moving back
3. Alignment of pyrotechnic chain
4. Non-return moving forward

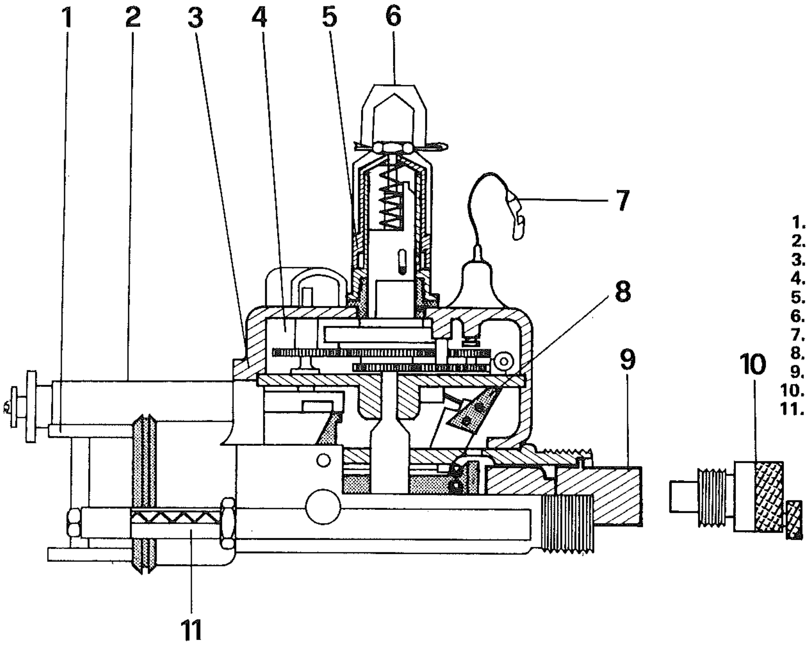
4. INERTIA OPERATION



1. Shearing of cocking shaft
2. Bush locked by the retaining ring and definitive locking of the striking pin

Figure 1-80.

MATRA TYPE 200A TAIL DEVICE



1. PARACHUTE LOCKING AND HOOKING DEVICE
2. ROCKET ARMING MECHANISM
3. CASE BODY
4. GEARS TRAIN
5. WINDING MECHANISM
6. SHIM
7. CABLE
8. DECELERATION SAFETY DEVICE
9. TAIL FUZE TYPE 20
10. PYROTECHNIC PORTION M14FRC
11. PARACHUTE WITHDRAWAL CONTROL

Figure 1-81.

M115, M116 AND M117 TAIL FUZES

Tail fuzes of this type are vane-operated and inertia-fired. Their arming is mechanically delayed by reduction gearing.
The fuzes in this series differ in overall length so they can be used in various size bombs (see T.O. 11-1-28).

M178, M179 AND M180 TAIL FUZES

These fuzes have the same operating characteristics as the M112A1 series (no reduction gear, fast arming) but incorporate the longer arming stem necessary for use with a conical fin assembly (see T.O. 11-1-28).

M181, M182 AND M183 TAIL FUZES

These fuzes have the same operating characteristics as the M115 series (reduction gear) and they also incorporate the longer arming stem necessary for use with conical fin assemblies (see T.O. 11-1-28).

M123A1, M124A1 AND M125A1 TAIL FUZES

Vane-operated tail fuzes of this type (see T.O. 11-1-28) incorporate an antiwithdrawal device and are designed for special applications. The fuzes act to detonate the bomb after a delay from 1 to 144 h.
Tail fuzes M123A1, M124A1 and M125A1 differ in overall length so that the same type fuze can be used in various size bombs.

PART 7 - TRAINING WEAPONS AND EQUIPMENT

SPECIAL STORE SYSTEM

This system permits to drop smoke cartridges, flares, incendiaries, practice bombs and other special stores enclosed in containers or mounted on adapters. The containers and adapters are fitted to the pylon through the rack.

Release of special stores is possible only on condition that either the landing gear control lever is set at UP (aircraft in flight with the landing gear retracted) or the "GROUND FIRE" switch is held in the ON position (during ground tests).

To arm the system for special store release, it is necessary that the "EXT STORES" selector switch on the armament control panel be set to SPL. Depressing the arming push-buttons of the pylons carrying the special stores that it is desired to release, energizes the solenoid each selected arming push-button which is thus retained in the depressed position.

When the release armament safety switch is operated, the lights in the selected arming push-buttons come on. At this stage, to release the armed stores it is sufficient to push the release push-button on the control stick grip. This energizes the special store container or adapter. As the special stores enclosed in the container or mounted on the adapter are released, a microswitch is actuated which breaks the circuit to the solenoid of the arming push-buttons. The lights in the arming push-buttons will then go out and the push-buttons will trip back to the original position, thus indicating that all special stores have been released.

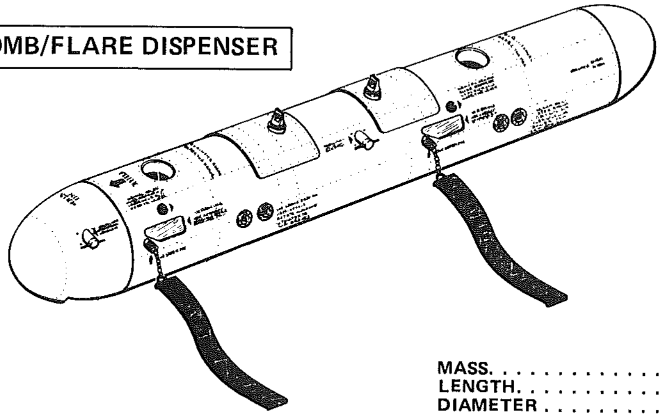
MACCHI 11B29-003 BOMB/FLARE DISPENSER (fig. 1-82)

The Macchi 11B29-003 practice bomb/flare dispenser is designed to carry and release four 25-pound practice bombs or 30-pound flares and other similar stores. The dispenser has four electromechanical bomb racks internally installed. Each rack is provided with a sway brace mechanism controlled by a single screw accessible from the outside. The sway brace mechanism is used to align and secure each store in position after it is loaded on the dispenser. A transfer switch in the dispenser transfers the electrical release impulse from one rack to another whenever the circuit is de-energized and then energized again.

The sequential order of bomb release is right rear, left rear, left front and right front.

The dispenser is designed for carriage from low performance up to subsonic aircraft having pylon conforming to STANAG 3441 fitted with 14 in. bomb racks. Two electrical receptacles are provided, one in the dispenser forward section and one in the rear

MACCHI 11B29-003 BOMB/FLARE DISPENSER



MASS	.60 lb
LENGTH	98.6 in.
DIAMETER	13.4 in.
LOADING STATIONS	4

Figure 1-82.

section, to facilitate utilization with different types of aircraft. An adapter harness designed to connect the two receptacles provided on the rack to the wing pylon receptacle, is provided for each specific installation.

The bomb container main structure houses four MA-4A racks. The practice bombs have single lug suspension, so only one hook of each rack is used, while the flares use both hooks of each rack.

The store loading consists of 4 ea. MK76 or BDU-33( ) pratice bombs or 4 ea. LUU-7B, LUU-2/B or MK24 flares.

PRACTICE BOMBS

MK86 PRACTICE BOMB (fig. 1-83)

Practice bomb MK86 Mod. 0 is a low-drag configuration, the same size and shape as the MK81 low-drag general purpose bombs. It has a streamlined nose and a conically tapered aft end. One filler hole is located on the side aft of the cylindrical section. Four fin blades, perpendicular to each other are located forward of the rear end of the bomb.

A blast tube extends from the nose to the aft end of the bomb and allows for exit the signal smoke when fired. The firing pin assembly and signal are held in place inside the blast tube by a retaining cotter pin. Double suspension lugs are spaced 14 inches apart on the body of the MK86 Mod. 0. Screw-in lugs are used with the low-drag general purpose bomb family. A hoisting lug is provided at the center of gravity of the bomb. Practice bomb signal MK4 Mod. 3 is used with MK86 Mod. 0. Practice bomb MK86 Mod. 1 is similar to the MK86 Mod. 0. The major differences between the two mods are that the Mod. 1 uses an integrally-welded suspension lug and a slightly different internal design.

AN-M38A2, 100 lb, PRACTICE BOMB (fig. 1-84)

AN-M38A2 is a round-nosed cylindrical bomb designed to simulate GP bombs.

The pin is assemblied to the bomb body which is empty.

At the moment of use, 80 lb of sand are poured into the bomb case, and spotting charge added to create the complete round.

The spotting charge is assembled in a sleeve at the base of the bomb.

The authorized spotting charge is the charge, spotting assembly, M1A1, for practice bombs, 100 lb M28A2 (blackpowder).

However, spotting charge assemblies M3 and M4 may also be used.

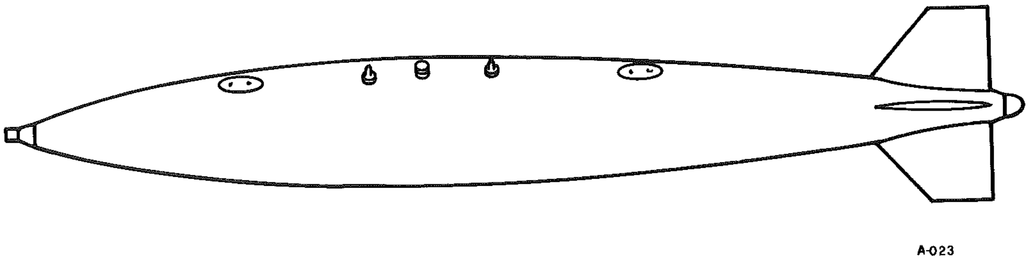
These assemblies consist of a 3 lb charge and an integral fuze consisting of an inertia type fusing and a black powder loaded shotgun shell as primer.

The M3 produced a large cloud of black smoke and is authorized over snow-covered ranges.

M4 is authorized for use on ranges equipped with sonic spotting devices.

The M1A1 is used for all other purposes.

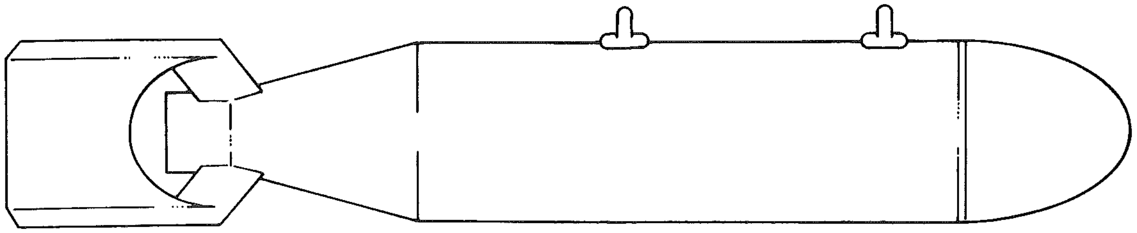
MK86 PRACTICE BOMB



MASS, EMPTY	64.5 lb
MASS, LOADED	with wet sand 217 lb with water 141 lb
LENGTH	76 in.
DIAMETER	9 in.
FIN SPAN	12.6 in.
FUZE	Practice Bomb Signal MK4 Mod 3 Firing-Pin Assembly MK1 Mod 0

Figure 1-83.

AN-M38A2 PRACTICE BOMB



MASS, EMPTY	5.8 lb
MASS, LOADED	with wet 8 and 100 lb
LENGTH	47.5 in.
DIAMETER	8.12 in.

Figure 1-84.

Sand Loading to Increase Mass

Remove the bomb from the carton and, inspect for serviceability. Remove the cover from its place in the sleeve. Place the bomb upright and fill completely with a uniform sand mixture. Shake the load down so that there will be no room for shifting. If a lighter loading is desired, mix dry saw-dust and dry sifted ashes with the sand. The bomb must be filled and the loading material uniform. Press the closing cap into place.

Assembly of the Spotting Charge

Insert spotting charge assembly and seat firmly with arming pin pointing away from bomb suspension lugs. Pass arming wire through rear suspension lug and then through the eyelet in the arming pin. Adjust the arming wire to extend 2 or 3 in. beyond the arming pin.

MK76 MOD 2 OR BDU-33( )/B, 25 lb, PRACTICE BOMBS (fig. 1-85)

Practice bomb MK76 Mod 2 or BDU-33( )/B has a tear-drop shaped, cast metal body which is centrally bored. The tail tube assembly fits into the end of the bore. The conical after body covers the tail-tube assembly and is threaded to the body. The two sections are stuck together to prevent unscrewing. The fin assembly is welded to the tail tube. Firing pin assembly MK1 Mod 0 and the signal are assembled into the bore of the body and secured in place by safety (cotter) pin.

11B81-008 Adapter (fig. 1-86)

MK76 and BDU-33( ) bombs can be suspended directly to the front hook of the pylon as well as into a qualified bomb dispenser. The Aermacchi 11B81-008 adapter is designed to be fitted in lieu of the front sway brace of the pylon. To install the adapter is necessary to remove both the sway braces from the pylon by pulling the relevant securing pin; then insert on the front seat the attachment of the adapter and secure with the pin.

PRACTICE AMMUNITION

SNEB TYPE 22 INERT HEADS FOR SNEB ROCKETS (fig. 1-87)

The head is ogive shaped in moulded alloy (zamak). It is internally threaded at the rear for screwing to the rocket motor. The head weights 800 g and has an overall lenght of 218 mm.
This type of head is used for practive in air-to-air roles of the type 21 P SNEB warhead.
The head can be converted for ait-to-ground use by fitting a spacing sleeve between the rear of the head and rocket motor, thus producing the same weight and ballistic characteristics of the air-to-ground rockets.
The same head with 1 kg of ballast replaces the SNEB head type 23.
By fitting 2 kg of ballast the head replaces the SNEB type 26 P warhead.

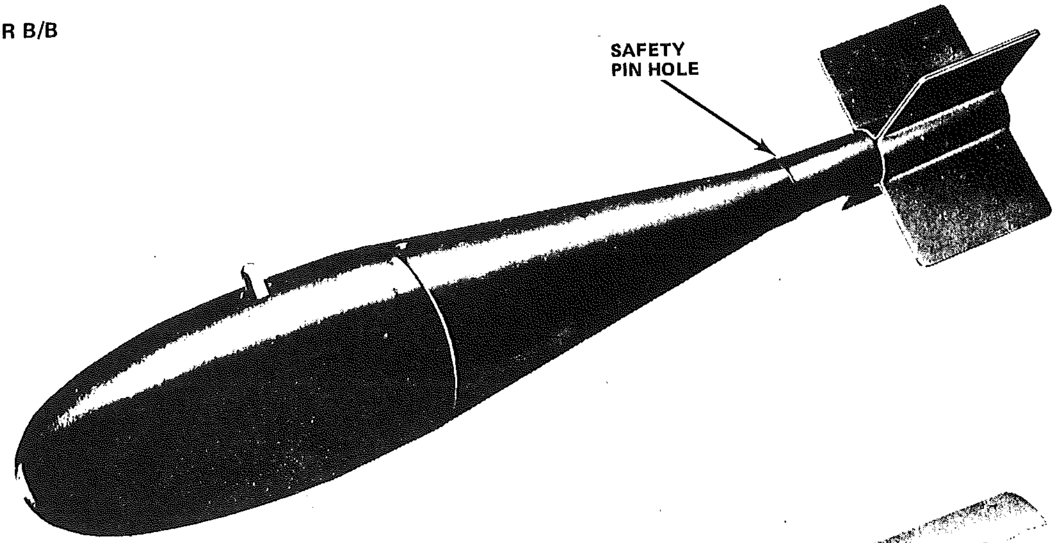
CAL 30 mm PRACTICE MUNITIONS

Practice munitions for DEFA 553 gun, caliber 30 mm are:

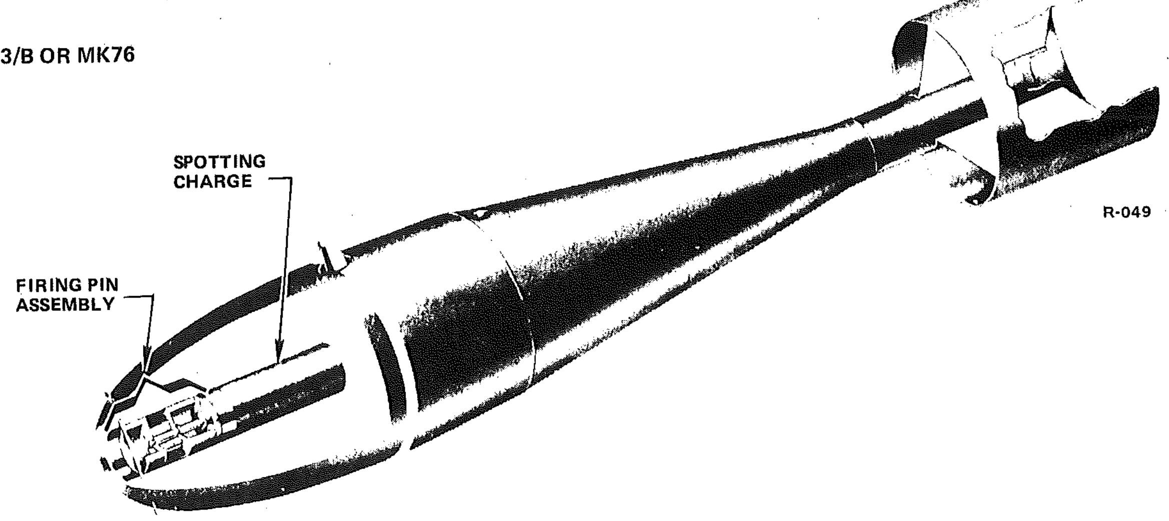
- DEFA type 2102 and type 2102F.
  Belts can be composed of homogeneous 2102 Frounds or as follows: 1 round 2102F, 5 rounds 2102.

BDU-33 ( )/B, BDU-33/B AND MK76 PRACTICE BOMBS

BDU-33A/B OR B/B



BDU-33/B OR MK76



MASS	23.7 lb
DIAMETER	3.87 in.
LENGTH	22.5 in.
FUZE	Signal MK4 Mod 3 Firing Pin Assembly MK1 Mod 0

Figure 1-85.

11B81-008 ADAPTER

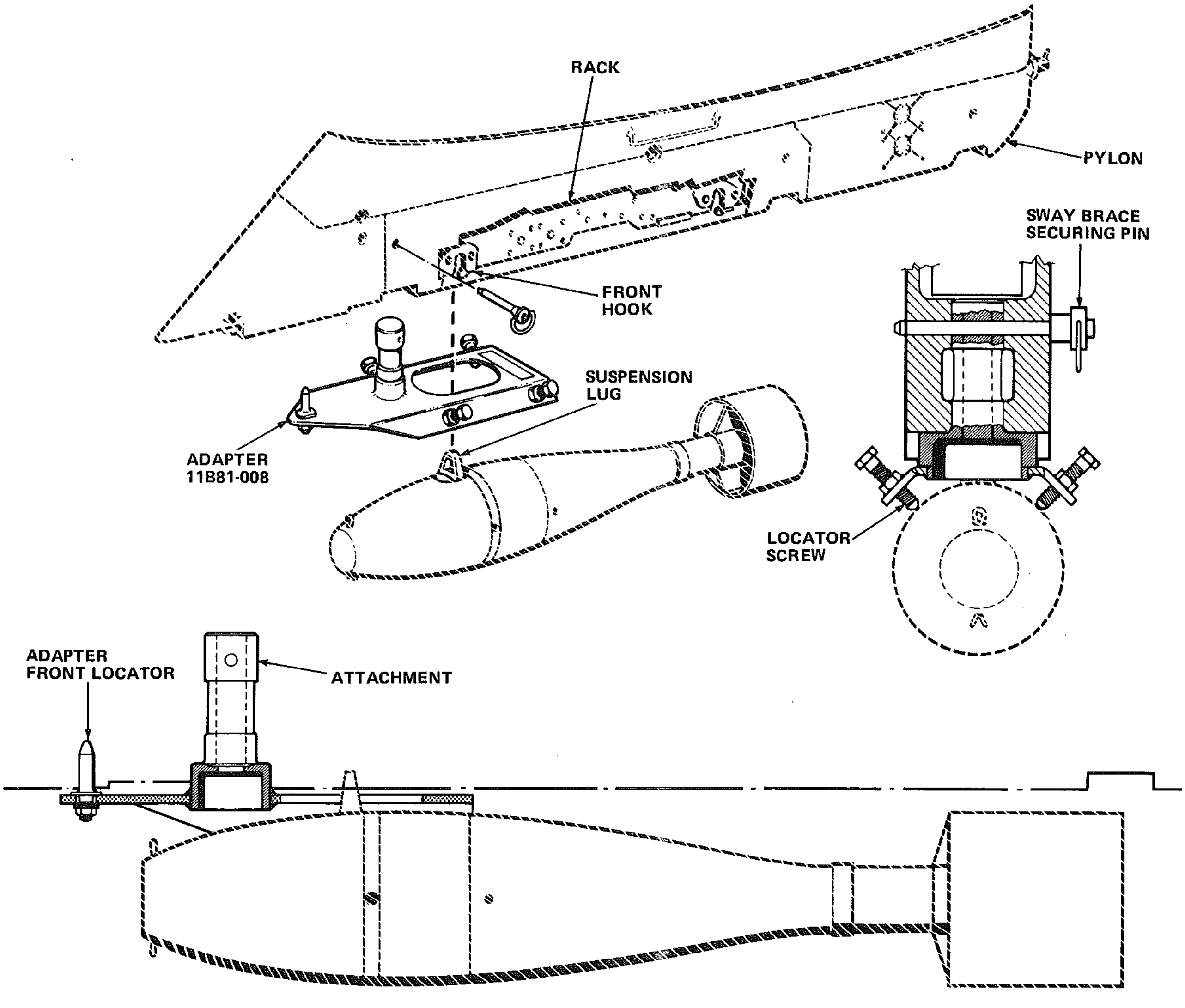
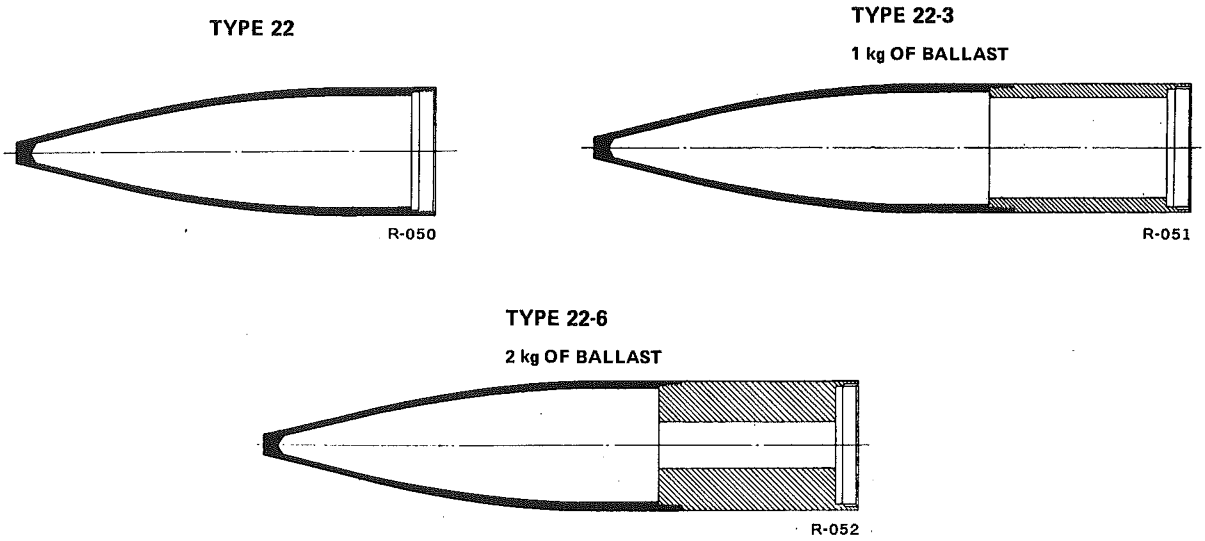


Figure 1-86.

SNEB TYPE 22 INERT HEADS



TYPE 22

TYPE 22-3
1 kg OF BALLAST

TYPE 22-6
2 kg OF BALLAST

Figure 1-87.

- CART 30-550-OXL-T 2560*.
  To be used in homogeneous belts.

CAL .50 in. PRACTICE MUNITIONS

Practice munitions for Browing-Colt type AN-M3, cal. 0.50 in., gun are the M2 and M33 ball (unpainted tip).

CAL 7.62 mm PRACTICE MUNITIONS

Practice munitions for cal. 7.62 mm (0.30 in.) guns are the M59 and M80 ball cartridges (unpainted tip).

SECTION II

NORMAL AIRCREW PROCEDURES

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INTRODUCTION

The purpose of this Section is to provide the pilot with normal, amplified procedures, necessary to perform ground, launch, inflight and post-flight operations in the execution of weapons attaks against air and ground targets.
Where text or illustration are not specifically identified for particular models, it may be assumed that such items are common to all aircraft. Illustrations, which do not show minor variations in the aircrfat models are normally labelled "Typical". Text and illustrations applicable to specific models are identified by the code symbols specified in this Manual foreword.

PREFLIGHT, INFLIGHT, LAUNCH AND DEARMING CHECKS

The aircraft is fitted with an armament safety connector, located on the external L.H. side of the pilot's cabin.
When plugged into the SAFE receptacle, the above connector, named EASC, functions to ground all the jettison and release armament electrical system, except for the "EXT STORES JETTISON" control. Connector displacement from SAFE to READY must only be performed when carrying out armed flight missions (for operations or training) upon entering the runway for take-off.
After this operation, the pilot shall check that the "ARMT CUT" caution light, on the armament control panel goes out. When the above operations have been carried out, safety of all the armament system is ensured by the "MASTER" switch, mounted on the top left-hand corner of the armament control panel.
The first after flight operation to be carried out on an armed aircraft, immediately after leaving the landing runway, will consist of returning the armament safety connector to the SAFE position and checking the "ARMT CUT" light coming on again.
When pre-setting the armament system for operation the "MASTER" switch must therefore be armed last (i.e. when starting the firing run or the release run) and returned to SAFE immediately after the pull-up following the firing operation so as to prevent any inadvertent weapon release operations of the pilot between one strafing or bombing-pass and the following one, thus avoiding indesired weapon release over populated areas.
A list of the checks to be carried out for an armed flight mission is given hereunder and may vary depending upon the type of weapons to be selected for release.
The missions involving use of different types of weapons, must include the following:

- "Pre-flight" checks concerning all the different kinds of weapons located for the flight mission.
- "Prior to relase" or "prior to fire" checks concerning respectively the store to be released or the weapon to be fired during the strafing or bombing-pass which is going to be carried out.
- "After firing" checks before leaving the firing range (or immediately after leaving the combat area) concerning all the types of weapons used during the mission.

- "After landing" checks concerning all the types of weapons used during the mission.

DEFA TYPE 553 CANNON

PREFLIGHT PROCEDURE

1. External armament safety connector (EASC) - SAFE.
2. Circuit breakers - Check "IN" as follows:
   - GUNS
   - SIGHT
   - SIGHT & GUN CAMERA
   - ARMT
   - ARMT SEL
   - ARMT MSTR
3. "ARMT CUT" caution light - Check on.
4. Gun fairings - Tight and secured.
5. Gun camera check - Completed.
6. "GYRO MASTER" switch - ON (Aircraft [A]).
7. Armament control panel - Check as follows:
   - "MASTER" switch - SAFE
   - "GUNS" switches (2) - OFF
   - Cannon operating mode selector switch - FREE or PROGR
   - Cannon rounds indicators (2) - Check to zero.
8. Guns armed by ground crew according to local procedures.

WARNING

> Ensure the aircraft is headed into a safe area when cannons are being armed.

9. External armament safety connector (EASC) - Plugged to ARM prior to take-off. Check that "ARMT CUT" caution light goes off.

PRIOR TO FIRING PROCEDURE

1. Aeritalia gunsight (Aircraft [B]): Check and adjust reticle lighting. Set computed depression angle.
2. Thomson R322Z(M) gunsight (Aircraft [A]):
   - a. Sight switch - ON.
   - b. Select G or GAA mode.
   - c. Crosswind setting - As necessary.
   - d. Reticle - Adjust light intensity.
   - e. Yaw, then porpoise the aircraft to note the proper reticle deflection. The reticle should move on the reflector glass in a direction opposite to the direction of movement of the aircraft nose.
3. Thomson RD21 gunsight (Aircraft [B]).
   - a. Mode selector - Select AA (air-to-air).
   - b. Brightness knob - Adjust light intensity.
   - c. Reticle illumination - Check N, then S, return to N.
   - d. Range selection switch - Select D2 (500 yards).
   - e. Yaw, then porpoise the aircraft to note the proper reticle deflection. The reticle should move on the reflector glass in a direction opposite to the direction of movement of the aircraft nose.
   - f. Mode selector - Now select G1 and repeat the step e. checking the movement of the reticle to be "frozen" to a minimum extent.
   - g. Mode selector - Select the required AA, G1 or G2.
   - h. Manual depression knob - Necessary for air-to-ground only: set the computed depression angle using G1 for values from 0 to 100 mils and G2 for values from 100 to 200 mils (subtract 100 mils when using G2).
   - i. Range selection switch - Necessary for air-to-air only:
     - o Select D1 for 250 yards.
     - o Select D2 for 500 yards.
4. Armament control panel.
   - a. "MASTER" switch - ARM.
   - b. "GUNS" switches (2) - ON.
   - c. Cannon operating mode selector switch - PROG (or FREE).

   d. Store arming switches (6) - OFF.
   e. "SEQUENCE" switch - Any position.
   f. "BOMBS ARM" switch - SAFE.
   g. "SEL JTSN" switch - OFF.

WARNING

The guns are now ready to fire.

FIRING PROCEDURE

Aim at the target through the reticle. When the target is in range, squeeze the trigger to second detent.

AFTER FIRING PROCEDURE

1. Armament control panel.
   a. "MASTER" switch - SAFE.
   b. "GUNS" switches (2) - OFF.
2. Aeritalia gunsight (Aircraft [B]). Switch OFF the reticle lighting.
3. Thomson R322Z(M) gunsight (Aircraft [A]). Sight switch - OFF.
4. Thomson RD21 gunsight (Aircraft [B]). Brigtness knob - OFF.

AFTER LANDING PROCEDURE

1. External armament safety connector (EASC) - SAFE.
2. Guns - Dearmed in accordance with the local procedures.

WARNING

Ensure the aircraft is headed into a safe area when guns are being dearmed.

SUU-11( )/A GUN POD

PREFLIGHT PROCEDURES

1. External armament safety connector (EASC) - Plugged to SAFE.
2. Gun muzzle caps - Removed.
3. Pylon safety pins - Installed.
4. Pylons - Locked.
5. Sway braces - Tight.
6. Rate of fire switch - Select.

NOTE

Inside the pod, SUU-11B/A only.

7. All caps and fairings of the pod - Secured.
8. Pylon-to-pod electrical harness - Installed and secured to pod.
9. All circuit breakers on right console "ARMAMENT AND SECONDARY DC BUS" panel and "CAMERA CONTR", "ARMT MSTR", on the SECONDARY BUS panel - Check IN.
10. "SIGHT & GUN CAMERA" circuit breaker (PRIMARY BUS) - Check IN.
11. "GYRO MASTER" switch - ON (Aircraft [A]).
12. Gun camera check - Completed.
13. Front armament control panel - All switches in OFF or SAFE position.
14. Miniguns in the pods - Armed in accordance with the local procedures.

WARNING

Ensure that the aircraft is headed into a safe area when the guns are being armed.

15. Pylon safety pins - Removed before take-off.
16. External armament safety connector (EASC) - ARM prior to take-off. Check that "ARMT CUT" light goes off.

PRIOR TO FIRE PROCEDURE

1. Gunsight check: Same as described for DEFA Type 553 gun prior to fire procedure.
2. Armament control panel:
   - "MASTER" switch - ARM.
   - "GUNS" switches (2) - OFF.
   - Cannon operating mode selector switch - N/A.

- Store arming switches - Lift the switch(s) corresponding to the installed minigun pod(s).
- "ARMT CUT" light - Check off.
- "BOMBS ARM" switch - Any position.
- "SEL JTSN" switch - Check OFF.

Depress the "READY" push-button and check the green light comes on, check that the windows corresponding to the minigun underwing position(s) must show GUN.

WARNING

The miniguns are now ready to fire.

FIRING PROCEDURES

Aim at the target through the reticle. When the target is in range, squeeze the trigger to the second detent.

AFTER FIRING PROCEDURES

1. Armament control panel:
   - "MASTER" switch - SAFE.
   - Store arming switches - All OFF.
2. Gunsight:
   Same as described for DEFA Type 553 gun after firing procedure.

AFTER LANDING PROCEDURE

1. External armament safety connector (EASC) - SAFE.
2. Pylon(s) safety pin(s) - Installed.
3. Miniguns - Dearmed according to local procedures.

WARNING

Ensure the aircraft is headed into a safe area when guns are being dearmed.

4. Gun muzzle caps - Installed.

MACCHI M910-21-10 AND M910-22-10 MACHINE GUN POD

PREFLIGHT PROCEDURE

1. External armament safety connector - Plugged to SAFE.
2. Gun muzzle caps - Removed.
3. Front pod fairings - Secured.
4. Pod doors (3) - Fastened.
5. All circuit breakers of right console "ARMAMENT AND SECONDARY DC BUS" Panel - Check IN.
   "ARM MSTR" and "SIGHT" circuit breakers - Check IN.
6. "GYRO MASTER" switch - ON (Aircraft [A]).
7. Gun camera check - Completed.
8. Armament control panel - All switches in OFF or SAFE position.
9. Guns - Armed in accordance with local procedures.

WARNING

Ensure the aircraft is headed into a safe area when guns are being armed.

10. External armament safety connector - ARM prior to take-off and check that "ARMT CUT" caution light goes off.

PRIOR TO FIRING PROCEDURE

Same as described for SUU-11( )/A minigun pod.

FIRING PROCEDURE

Same as described for SUU-11( )/A minigun pod.

AFTER FIRING PROCEDURE

Same as described for SUU-11( )/A minigun pod.

AFTER LANDING PROCEDURE

1. External armament safety connector - SAFE.
2. Guns - Dearmed according to local procedures.

WARNING

Ensure the aircraft is headed into a safe area when guns are being dearmed.

3. Gun muzzle caps - Installed.

GP FRAGMENTATION AND LOW DRAG BOMBS

PREFLIGHT PROCEDURES

NOTE

All bomb fins must be in X configuration.

1. External armament safety connector - SAFE.
2. Pylon safety pins - Installed.
3. Pylons - Locked.
4. Sway braces - Tight.
5. Arming wires - Installed.
6. Fuzes check - Check that arming wire is threaded through vane-stop eyelets and is approximately 4 inches in legth. Check for proper type fuzes and correct time settings, and that the fuze Safety Devices are removed.

WARNING

M904E1, M904E2, M905 fuze: if the window in the fuze body shows full red, the fuze is unsafe and should not be touched. Call explosive ordnance disposal (EOD) personnel immediately.
M904E3 fuze: if the window in the fuze body shows a black "A" on a red background, the fuze is armed and should not be touched. Call EOD personnel immediately.

7. All circuit breakers on right console "ARMAMENT AND SECONDARY DC BUS" panel - Check IN.
"ARMT MSTR" and "SIGHT" circuit breakers - Check IN.
8. "GYRO MASTER" switch - ON (Aircraft [A]).
9. Armament control panel - All switches in SAFE or OFF position.
10. Pylon safety pins - Removed before take-off.
11. External armament safety connector - ARM prior to take-off and check that "ARMT CUT" caution light goes off.

PRIOR TO RELEASE PROCEDURES

1. Aeritalia gunsight (Aircraft [B]): Check and adjust reticle lighting. Set computed depression angle.
2. Thomson R322Z(M) gunsight (Aircraft [A]):
   a. Sight switch - ON.
   b. Set crosswind component.
   c. Select B1 for computed depressions from 0 to 100 mils; select B2 for computed depressions from 100 to 200 mils.
   d. Set the desired sight depression angle (if mode switch is B2 subtract 100 mils from the computed depression angle).
   e. Reticle illumination - Check N, then E (emergency), then return to N (normal).
   f. Brightness knob - Adjust light intensity.
3. Thomson RD21 gunsight (Aircraft [B]):
   a. Mode selector - Set G1 or G2 (use G1 for computed depressions from zero to 100 mils, use G2 for computed depressions from 100 to 200 mils).
   b. Manual depression knob - Set computed depression (if the mode switch is on G2: subtract 100 mils from computed depression angle).
   c. Reticle illumination - Check N then S, return to N.
   d. Brightness knob - Adjust light intensity.
   e. Range selection switch - Any position.
4. Armament control panel:
   a. "MASTER" switch - Set to ARM.
   b. "ARMT CUT" caution light - Check off.
   c. "GUNS" switches (2) - OFF.
   d. Store arming switches - Set ON the switches corresponding to the bombs to be released at the first pass.

e. "SEL JTSN" switch - OFF.

f. "READY" push-button - Depress and check the green light comes on and the word BOMB is in view on the indicator windows of the "armed" underwing stations.

g. "SEQUENCE" switch - Any position.

h. "BOMBS ARM" switch - Move to NOSE & TAIL or TAIL ONLY.

WARNING

The bombs are now ready to be released armed.

RELEASE PROCEDURE

Aim at the target through the reticle. When the target is in range, or the release altitude is attained, push the release button on the stick grip.

AFTER RELEASE PROCEDURE

1. Armament control panel:
   a. "MASTER" switch - SAFE.
   b. Store arming switches - OFF.
   c. "BOMBS ARM" switch - SAFE.
2. Aeritalia gunsight (Aircraft [B]). Reticle switch - OFF.
3. Thomson R322Z(M) gunsight (Aircraft [A]):
   a. Sight switch - OFF.
   b. Check reticle disappeared.
4. Thomson RD21 gunsight (Aircraft [B] →).
   Brightness knob - OFF.

AFTER LANDING PROCEDURE

Unexpended bombs only:

a. External armament safety connector - SAFE.

b. Pylon safety pins - Installed.

AEREA 559G1 FIRE BOMBS

PREFLIGHT PROCEDURES

1. External armament safety connector - SAFE.
2. Pylon safety pin - Installed.
3. Pylons - Locked.
4. Sway braces - Tight.
5. Arming wires (2) - Installed.

WARNING

The white phosphorous in the igniter liquifies at 44°C and may leak through the filler plug, if exposed to high temperatures. Leaking ignites can be determined by the presence of white material on the igniter. If any of these conditions are observed, notify Explosive Ordnance Disposal (EOD) personnel immediately.

6. All circuit breakers of right console "ARMAMENT AND SECONDARY DC BUS" panel - Check in.
7. "ARM MSTR" and "SIGHT" circuit breakers - Check IN.
8. "GYRO MASTER" switch - ON (Aircraft [A]).
9. Armament control panel - All switches in SAFE or OFF position.
10. Pylon safety pin - Removed before take-off.
11. EASC - Plugged to ARM prior to take-off and check that "ARMT CUT" light goes off.

PRIOR TO RELEASE PROCEDURES

1. Gunsight check - Same as described for GP bombs.
2. Armament control panel:
   Same checks as per GP bombs release.

WARNING

The fire bombs are now ready to be released ARMED.

RELEASE PROCEDURES

Aim at the target through the reticle. When the target is in range push the release button on the stick grip.

AFTER RELEASE PROCEDURES

Same as described for GP bombs.

AFTER LANDING PROCEDURES

Unexpended fire bomb only.

a. EASC - SAFE.

b. Pylon safety pins - Installed.

c. Initiator safety pins - Installed.

MACCHI 11B29-003 BOMB FLARE DISPENSER

PREFLIGHT PROCEDURES

1. EASC - SAFE.
2. Pylon safety pin - Installed.
3. Pylons - Locked.
4. Sway braces (pylon-dispenser) - Tight.
5. Pylon-to-dispenser harness (rear receptacle) - Secured to dispenser and connectors in place.
6. Practice bomb/flares sway braces - Tight bomb/flare suspension - Check coked.
7. Dispenser shorting devices - Installed.
8. Practice bombs/flares arming wires - Installed.
9. Practice bombs/flares safety pins - Installed.
10. All circuit breakers on right console "ARMT AND SECONDARY DC BUS" panel - Check IN.
    "ARM MSTR" and "SIGHT" circuit breakers - Check IN.
11. "GYRO MASTER" switch - ON (Aircraft [A]).
12. Armament control panel - All switches in SAFE or OFF position.
13. Pylon safety pin - Removed before take-off.
14. RDU 33( )/B safety pins or flares safety pins - Removed before take-off.
15. EASC - Plugged to ARM prior to take-off and check that "ARMT CUT" light goes off.

PRIOR TO RELEASE PROCEDURE

1. Gunsight check: Same as described for GP bombs; not necessary for flare release.
2. Armament control panel:
    a. "MASTER" switch - ARM.
    b. "GUNS" switches (2) - OFF.
    c. Store arming switches corresponding to the suspended dispenser - ON.
    d. "READY" push-button - Depress and check green light and the word DISP appearing on windows.
    e. "SEQUENCE" switch - Any position.
    f. "BOMBS ARM" switch - NOSE & TAIL.
    g. "SEL JETSN" - OFF.

WARNING

The Flares/Bombs are now ready to be relased.

RELEASE PROCEDURES

1. For practice bombs release - Aim at the target through the reticle. When the target is in range, push the release button on the stick grip.
2. For flare release - Keep the aircraft level at the computed release altitude. Head the aircraft to the target allowing the up-wind correction. When at the computed distance to the target push the release button on the stick grip.

NOTE

Each time the release button is depressed one bomb or flare shall be dropped from each dispenser "armed". A transfer switch on the dispenser transfers the electrical release impulse from one rack to another whenever the circuit is de-energized and then energized again. The sequential order of Flare/Bomb release is: right rear, left rear, left front, right front.

AFTER RELEASE PROCEDURE

Same as described for GP bombs.

NOTE

When one dispenser is empty the corresponding window of the armament panel shall show the word EMPTY.

AFTER LANDING PROCEDURES

1. EASC - SAFE.
2. Aircraft pylon safety pin - Installed.

3. Unexpended bombs/flares only:
   a. Bombs safety pins - Installed.
   b. Flares safety pins - Installed.

MK86, BDU33( )/B, MK76 AND AN-M38A2 PRACTICE BOMBS

PREFLIGHT PROCEDURES

1. EASC - SAFE.
2. Pylon safety pin - Installed.
3. Pylons - Locked.
4. Sway braces - Tight.
5. Bomb safety pin - Installed.
6. All circuit breakers of "ARMT AND SECONDARY DC BUS" panel - Check IN. "ARMT MSTR" and "SIGHT" circuit breaker - Check IN.
7. "GYRO MASTER" switch - ON (Aircraft [A]).
8. Armament control panel - All switches in SAFE or OFF position.
9. Pylon safety pin - Removed before take-off.
10. Bomb safety pin - Removed before take-off.
11. EASC - Plugged to ARM prior to take-off and check that "ARMT CUT" light goes off.

PRIOR TO RELEASE PROCEDURES

1. Gunsight check - Same as described for GP bombs.
2. Armament control panel - Same as per GP bombs prior to release procedure. Store arming switches - Put on only the switch corrsponding to the practice bomb(s) to be released at the bomb-pass.

WARNING

The selected practice bombs are now ready to be released.

RELEASE PROCEDURES

Aim at the target through the reticle. When the target is in range depress the release button on the stick grip. The selected bomb/bombs will drop.
Repeat the pylon hooks arming as necessary for the subsequent pass bomb delivery, by raising the switch corresponding to the selected bomb.
Repeat the aiming and release procedures as manu times as necessary.

AFTER RELEASE PROCEDURES

Same as described for GP bombs.

AFTER LANDING PROCEDURES

1. EASC - SAFE.
2. Pylon safety pin - Installed.
3. Unexpended bombs nose safety pins - Installed.

FOLDING FIN AIRCRAFT ROCKETS (FFAR) (ANY TYPE)

PREFLIGHT PROCEDURES

1. EASC - SAFE.
2. Pylon safety pin - Installed.
3. Pylons - Locked.
4. Sway braces - Tight.
5. Pylon-to-launcher harness - Secured.
6. Launcher shorting devices - Installed.

WARNING

If the shorting device is not installed, the rockets may be inadvertently fired.

7. Launcher intervalometer - Installed and set.
8. Rockets - Locked in detents.
9. Rocket igniters - Installed.
10. Fairings - Installed as required.
11. All circuit breakers of "ARMT AND SECONDARY DC BUS" panel - Check IN. "ARMT MSTR" and "SIGHT" circuit breakers - Check IN.
12. "GYRO MASTER" switch - ON. (Aircraft [A]).
13. Armament control panel - All switches in OFF or SAFE position. All lights OFF.
14. Shorting devices - Removed before take-off.
15. Pylon safety pin - Removed before take-off.

16. EASC - Plugged to ARM prior to take-off and check that "ARM CUT" light goes off.

WARNING

- Ensure aircraft is headed into a safe area when shorting devices are removed.
- Do not lower flaps until shorting devices have been removed.

PRIOR TO FIRE PROCEDURES

1. Gunsight check - Same as described for GP bombs.
2. Armament control panel.
    a. Store arming switches - Put on the switches corresponding to the rocket launchers to be fired at the first pass.
    b. "READY" push-button - Depress and check the green light is on and the word RKT appearing in the windows corresponding to the rocket launchers armed for fire.
    c. "ARMT CUT" caution light - Check off.
    d. "SEQUENCE" switch - Set to SGL (in order to fire one rocket from each of the "armed" launcher) or RIPPLE (in order to fire all the rocket from each of the "armed" launchers in very rapid sequence).
    The INTVLM position is inoperative.
    e. "MASTER" switch - ARM.

WARNING

The FFAR are now ready to be fired.

FIRING PROCEDURES

Aim at the target through the reticle. When the target is in range depress the armament release button (bomb/rocket) on the stick grip and maintain it depressed until the rocket, or rockets, are fired in sequence. When all the rockets contained in a launcher are fired the corresponding window of the armament panel shall show the word EMPTY.

AFTER FIRING PROCEDURES

1. "MASTER" switch - SAFE.
2. Store arming switches - OFF.

AFTER LANDING PROCEDURES

1. EASC - SAFE.
2. Pylon safety pins - Installed.
3. Launcher with unexpended rockets - Install shorting device.

A-6B TOW TARGET

GENERAL

The aircraft is provisioned to carry the aerial banner target type A-6B for gunnery practice.
The banner is attached to a hitching bracket fitted to the speed brake inside channel which can be released when the target banner is required to be detached from the towing aircraft. The minimum runway length recommended for use with the tow target is 2000 m (6600 ft).

CABLE HOOKUP

Before hookup the tow target and cable are stretched out on the runway overrun, if available. If the overrun is not available, use approximately the first 350 m (1000 ft) of the runway unless the runway approach terrain is exceptionally smooth and hard and the dropoff at the end of the runway is very slight, thereby preventing the moving target from being snagged. If a cross wind exists, ensure that target and cable are located approximately 8 m (25 ft) from the up-wind edge of the runway.

BANNER TARGET HOOKUP PROCEDURE

WARNING

Take all precautions as necessary to preclude the possibility of serious accidents resulting from inadvertent retraction of the speed brake during target hookup.

1. Align the aircraft with the runway, apply brakes and hold the aircraft braked.

2. On signal from the specialist, extend the speed brake.
3. "SPD BRAKE" circuit breaker - OFF.

WARNING

During the hook-up procedure, avoid carrying out any operation in the cabin so as to preclude any inadvertent speed brake retraction.

4. After target hookup has been completed, await for the specialist's signal and proceed as follows:
   a. "SPD BRAKE" circuit breaker - Push IN.
   b. Retract the speed brake.
5. Advance the aircraft slowly to stretch the tow cable.
6. When the cable is taut, stop the aircraft.

TAKE-OFF

1. Flaps for take-off. Advance throttle to 100% rpm and, on "go" signal, start the take-off run.
2. Add 20 kt to computed take-off speed. Allow the aircraft to fly off the ground in a normal take-off attitude.

WARNING

Do not pull the aircraft off the runway.

3. When vertical velocity indicator indicates a climb and altimeter indicates an increase of altitude, operate the landing gear lever to UP and smoothly establish a speed of 125 KIAS.

WARNING

During any emergency jettison the target immediately by estending the speed brake.

CLIMB AND CRUISE

1. When 500 ft above the ground, operate the flaps lever to up and climb at 140 kt.

NOTE

Use full throttle during the climb. Since the aircraft with target in tow will not climb well during turns above 15 000 ft, it is important to plan the climb to altitude and firing area using a minimum number of turns.

2. Disengage the "SPD BRAKE" circuit breaker.
3. The optimum towing speed is 165 to 170 KIAS.

CAUTION

Never exceed a speed of 200 KIAS.

TARGET RELEASE

1. Recommended minimum altitude: 500 ft terrain clearance.
2. Speed: 150 KIAS; maintain straight and level unaccelerates flight.
3. Engage the "SPD BRAKE" circuit breaker.
4. Extend the speed brake.

NOTE

The drogue will release the bracket approximately at half of the speed brake full travel.

5. When release has taken place, retract the speed brake.

LANDING

Carry out a normal landing procedure.

SECTION III

EMERGENCY AIRCREW PROCEDURES

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INTRODUCTION

Emergency procedures contained in this Section apply to all munition covered in this manual. Basic aircraft emergency procedures and jettisoning restrictions are covered in the Flight Manual.

LOADS JETTISON

WARNING

Unless immediate emergency action is needed, make sure to jettison loads within the permissible airspeed and load factors listed in the Flight Manual.

To jettison all pylon weapons, launchers and tanks:

1. "EXT STORES JETTISON" push-button - Push.

NOTE

Macchi machine gun pod and photo-reconnaissance pod are not jettisonable.

SELECTIVE JETTISON

Selective jettison has the same function as external stores jettison except that a specific station or stations (1 through 6) must be selected, the corresponding store arming the pylon readied for jettison its load.

CAUTION

Do not jettison external loads to the extent that the asymmetrical load limit is exceeded. Refer to the Flight Manual.

1. Armament control panel:
   a. "MASTER" switch - ARM.
   b. "SEL JTSN" switch - ON.
   c. Store arming switch - Up the switch(s) corresponding to the store(s) to be jettisoned. The "READY" caution light must illuminated with amber light.
   All other switches can be in any position.
2. Realease push-button on the stick grip - Depress.

NOTE

The stores are dropped in SAFE conditions since the supply of power to the FUSE switch is cut off.

HUNG ORDNANCE

The term "Hung Ordnance" is applied to munitions that have failed to release or jettison.
If hung ordnance occurs:

1. All store arming switches - OFF.
2. "SEL JTSN" switch - ON.

3. Store arming switch corresponding to the hung ordnance - ON.
4. "READY" caution light- Check amber light on.
5. "MASTER" switch - ARM.
6. Release push-button on the stick grip - Depress to jettison ordnance over a safe area.

If still not released:

7. Attempt to jettison munitions over a safe area using the LOADS JETTISON procedure.

CAUTION

With the LOADS JETTISON procedure all the loads suspended to the pylons will be dropped, included pods and pylon tanks. So far this procedure has to be applied for aircraft safety purpose only.

WARNING

Following an attempted release or jettison, any munition that does not separate from the aircraft should be considered susceptible to inadvertent release during landing.

MALFUNCTION PROCEDURES

1. One or more of the following circuit breakers popped out: ARMT SEL, ARMT, FUZES, GUNS, ARMT MSTR, SIGHT, SIGHT & GUN CAMERA, STORES JETT.
   a. Armament control panel - All switches set to SAFE or OFF position.
   b. Push IN the circuit breaker(s) popped out.
      o If the circuit breaker(s) do not stay IN, ABORT THE MISSION.
      o If the circuit breakers stay IN, return the switches of the armament control panel to the required position and re-check the breakers. If some circuit breakers is again popped OUT, ABORT THE MISSION. Return all switches of the armament control Panel to SAFE or OFF position.
2. "READY" green light does not come on but windows are showing the corret word.
   a. Assume to have a burnt bulb, continue the mission.

FIREFIGHTING AND EVACUATION CRITERIA

These emergency procedures consist of actions to be taken if munitions are involved in a fire. The aircrew should be thoroughly familiar with these instructions.
If the munition is envelopped by fire, it is imperative that time of fire is recorded. This action is required in order to determine time available to fight fire and evacuate the area before the munitions function. The following table gives the fire fighting withdrawal time in minutes which is the maximum time permitted to fight the fire. At the expiration of this time, the munition may be expected to function. See table in figure 3-1.

TOW TARGET EMERGENCY PROCEDURES

If, when flying with the target in tow, it is noted that the pressure reading on the main system pressure gauge is slowly dropping below 2000 psi, proceed as follows:

1. Abort the mission and reach the target release area or other open area.
2. Engage the "SPD BRAKE" circuit breaker.
3. Release the target by extending the speed brake with normal manoeuvre.

NOTE

For the emergency procedures regarding the landing gear and wing flaps, refer to the Flight Manual.

If the main hydraulic system pressure has dropped to zero, land with the target in tow according to the following procedure:

1. Advise the tower of the intention to land with the target in tow.
2. Set up the final approach so as to make the aircraft arrive on the end of the runway at an altitude of 300 ft and an airspeed not lower than 120 KIAS and a dive velocity not greater than 1000 ft/min.

FIRE FIGHTING AND EVACUATION DISTANCE

WEAPON TYPE	FIRE FIGHTING WITHDRAWAL TIME (1)	EVACUATION DISTANCE (FT)	
		FIRE FIGHTERS (2)	OTHER PERSONNEL
30 mm and 7.62 mm ammunition	N/A	FFOD	500
Cal .50 ammunition	N/A	FFOD	500
M 117 series bombs	5.0 min	1200	2000
MK 81 - MK 82 bombs	5.0 min	1200	2000
GP-AP and Drag bombs	5.0 min	1200	2000
All Fire Bombs	N/A	FFOD	500
Rocket Launchers	2.5 min	FFOD	2000
Practice Bombs	N/A	FFOD	500
M1A1 Fuze Extent.	1.0 min	FFOD	2000

(1): Time from when munition is enveloped in flame before it functions

(2): Anyone actively engaged in fighting the fire

N/A: Time is not a factor. Fire may be and should be fought from FFOD (Fire Fight Operational Distance)

Figure 3-1.

CAUTION

Emergency landing on runways less than 2000 m (6600 ft) in legth must have an approach altitude of 200 ft at the runway threshold. The possible presence of obstacles at the runway entry must also be considered.

3. Under the control of the tower, follow a final approach procedure such as to permit the aircraft to touch-down at approx. 1/3 of the runway.

NOTE

The control tower will provide the pilot with indications on possible patch corrections as necessary to prevent the target from snagging ground obstacles (barriers, trees, etc.).

4. As the target contacts the ground and breakage of shear bolts causes the target to be released, perform a go-around.
5. Repeat landing, following normal procedure.

SECTION IV

SUPPLEMENTARY DATA

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ERROR ANALYSIS - DIVE BOMBING - BDU-33( )/B PRATICE BOMB

In the dive delivery, the bomb is released from a fixed dive angle approach to the target. Release is accomplished manually at a preplanned airspeed and altitude. The aircraft flight path is projected beyond the target, by means of a depressed sight line, to compensate for the curvature of the bomb trajectory (see figure 4-1).

This Chart is drawn to scale for a BDU-33A/B and BDU-33B/B 15 degree dive, 300 KTAS, 1500 ft AGL release, 5 degree C of temperature at release altitude. The bomb range for this release condition (obtained from bombing table) is 3.069 feet. Therefore, for this release condition the bomb must be released at a horizontal distance of 3069 ft from the target at the planned 1500 ft AGL and 15 degree dive angle. If the 15 degree dive flight path is projected from the release point into the ground, it can be seen that sight depression sufficient to project the flight patch approximately 2529 ft beyond the target, it is required to compensate for the trajectory curvature.

15 DEGREE DIVE BOMBING

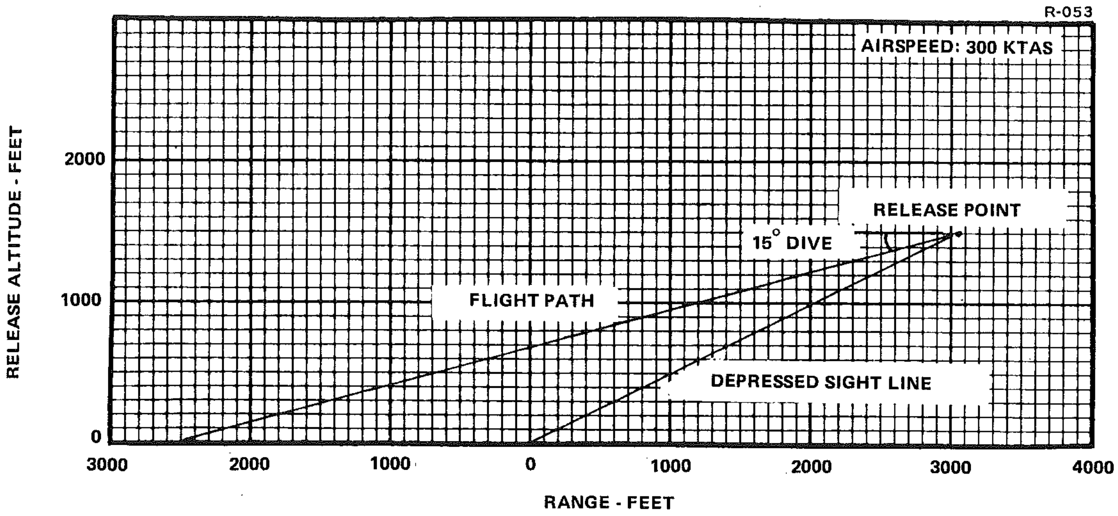


Figure 4-1.

Figure 4-2 provides similar data for initial conditions of a 30 degree dive, 2000 ft AGL, and 320 KTAS.

30 DEGREE DIVE BOMBING

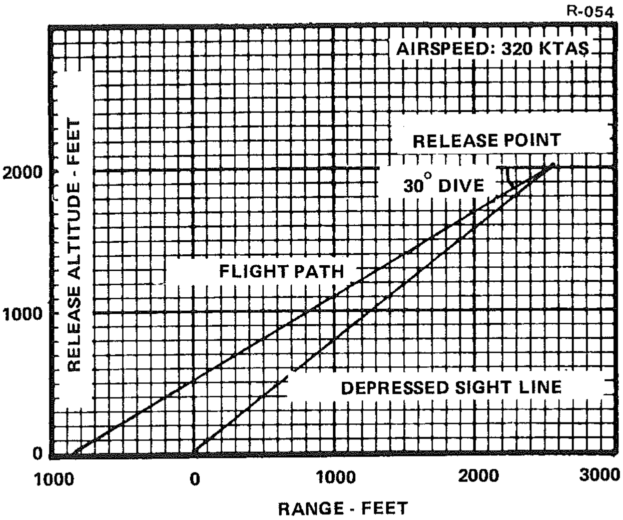


Figure 4-2.

Figure 5-1 illustrates the other items which must be considered in computing the depression setting which wil provide the required depression flight path. The formula used to compute setting is as follows:

$$\phi = 17.45 \left[\tan^{-1} \frac{Z_p}{R_p \pm W_R t} - \theta \right] + \alpha - \beta$$

Where:

ϕ = sight depression in mils.

Z_p = Z_R - (X parallax factor) sin θ = (Z parallax factor) cos θ

R_p = R - (X parallax factor) cos θ - (Z parallax factor) sin θ $+R_C$

Z_R = release altitude (AGL) in feet.

R = bomb range in feet under no wind conditons.

X parallax factor = 10.8 ft (mean).

Z parallax factor = 3.87 ft (mean).

R_C = range correction factor = $W_R \cdot t$

W_R = release rangewind component in ft/s. Headwind is minus; tailwind is plus.

t = bomb time of flight in seconds.

θ = release angle in degrees. This is the angle between the horizontal and the aircraft flight path.

α = fuselage reference line angle of attack in mils.

β = zero sight line orientation with respect to the aircraft fuselage reference line in mils.

The quantity:

$$17.45 \quad \tan^{-1} \frac{Z_p}{R_p \pm W_R t} - \theta$$

in the sight depression angle formula represents the depression angle from flight path which is listed in the bombing tables. It is a function of release altitude, bomb range, and dive angle. Bomb range, in turn, is a function of release altitude, dive angle, true airspeed, ejection velocity, and effective drag. Since many variables are involved and the depression setting is based on preplanned conditions, any deviation from preplanned conditions is bound to result in impact range error. The following paragraphs indicate the amount of impact error to be expected for certain deviations from palnned release TAS, altitude, or dive angle. The following standard or planned conditions are assumed:

a. Release TAS: 300 knots

b. Relase altitude: 1500 ft AGL

c. Release angle: -15 degrees

d. Aircraft gross mass: 8000 lb

e. Temperature at release altitude: 5°C (41°F)

f. Wind: Calm

g. Munition: BDU-33A/B

For these conditions, the sight depression from flight path is 194 mils, and the aircraft angle of attack at release is -17. So the zero sight line angle of attack is = (+26 -17) = +9 mils. Therefore, once the release depression setting has been assumed, the following equation determines an offset aimpoint required for a hit, if the actual release condition is different from the planned release conditions.

$$A = R_p - Z_p \cot \theta + \frac{\phi - \alpha A + \alpha P}{17.45}$$

Where:

A = offset aimpoint in feet.

Z_p = Z_R - (X parallax sin) θ + (Z parallax factor) cos θ

R_p = R - (X parallax factor) cos θ - (Z parallax factor) sin θ +R_C

X parallax factor = 10.8 ft

Z parallax factor = 3.87 ft

R = bomb range in feet.

Z_R = release altitude (AGL) in feet.

θ = release angle in degrees.

φ = planned depression angle from flight path in mils.

α A = actual angle of attack in mils.

α P = planned angle of attack in mils.

A is an aimpoint offset. If the bomb is released with the depressed sight on the target, it can be used to represent the impact error. The Z_p cos θ part of the formula provides the horizontal distance from release to target for the actual release condition. A positive A (offset) indicates a positive (long) error. The offset is zero if all conditions are met.

EFFECT OF RELEASE TAS ERROR

TAS = 295 kt (5 kt slower than planned) 15° dive 1500 ft AGL; A = +17 mils and R = 3037 ft.

$$A = R_P - Z_P \cot \theta - \frac{\phi - \alpha A + \alpha P}{17.45}$$

$$A = (3037 - 11.38) - (1500 - 1) \cot 15 + \frac{194 - 17 + 16}{17.45}$$

$$A = 3026 - 1499 \cot 15 + \frac{193}{17.45} = 3026 - 1499 \cot 26°06' = 3026 - 3058 = -32 \text{ ft (short-error)}$$

TAS 305 kt (5 knots faster than planned) 15° dive, 1550 ft AGL.

α A = +8 mils and R = 3099 ft.

$$A = (3099 - 11.38) - (1500 - 1) \cot 15 + \frac{194 - 15 + 16}{17.45} = 3088 - 1499 \cot 15 + \frac{195}{17.45} =$$

$$= 3088 - 1499 \cot 26°10' = 3088 - 3055 = +33 \text{ ft (long error).}$$

EFFECT OF RELEASE ALTITUDE ERROR

Altitude 1400 ft (100 ft lower than planned), 15° dive, 300 KTAS.

α A = 9 mils and R = 2928 ft

$$A = (2928 - 11.38) - (1400 - 1) \cot 15 + \frac{194 - 15.9 + 16}{17.45} = 2917 - 1399 \cot 26°06' =$$

$$= 2917 - 2854 = +63 \text{ ft (long error).}$$

Altitude 1600 ft (100 ft higher than planned), 15° dive, 300 KTAS.

$\alpha\ A = 9.2$ mils and $R = 3158$ ft.

$$A = (3158 - 11.38) - (1600 - 1) \cot \quad 15 + \frac{194 - 15.8 + 15.9}{17.45} \quad = 3147 - 1599 \cot 26°06' =$$

$$= 3147 - 3262 = -115 \text{ ft (short error).}$$

EFFECT OF DIVE ANGLE ERROR

Dive angle 14° (1° less than planned), 300 KTAS, 1500 ft AGL.

$\alpha\ A = 9$ mils and $R = 3158$ ft.

$$A = 3147 - 1499 \cot \quad 14 + \frac{194 - 16 + 16.1}{17.45} \quad =$$

$$A = 3147 - 1499 \cot 25°06' = 3147 - (1499 \times 2.134) = 3147 - 3199 = -52 \text{ ft (short error).}$$

Dive angle 16° (1° steeper than planned), 300 KTAS, 1500 ft AGL.

$\alpha\ A = 9$ mils and $R = 2982$ ft.

$$A = 2971 - 1499 \cot 27°06' = 2971 - (1499 \times 1.954) = 2971 - 2929 = 42 \text{ ft (long error).}$$

ERROR ANALYSIS - ROCKET LAUNCHING 2.75-in. FFAR

As in dive bombing, the depressed pipper is used to compensate for the curvature of the rocket trajectory from the launch point to impact. These projectiles can be delivered more accurately than a bomb under most circumstances because the high velocity attained after launch provides a much straighter trajectory with less time of flight. The following launch conditions were used as the standard for an error analysis study:

a. Airspeed - 360 KTAS

b. Altitude - 2500 ft

c. Angle - 30° dive

Errors caused by deviation of ± 20 kt from the 360 kt standard, ± 200 ft from the 2500 ft altitude standard, and ± 5° from the 30° dive standard were computed. The effects of these deviations from planned launch conditions on the 2.75-inch rocket impact are very small. The ± 20 kt airspeed deviations cause impact range errors of approximately ± 10 ft. The ± 200 ft altitude deviations cause impact range errors of approximately ± 5 ft. The ± 5° dive angle deviations cause impact errors of approximately ± 5 ft. These errors are much less than the normal rocket dispersion from the standard trajectory.

BOMBING ERRORS DURING MANUAL DELIVERIES

EFFECT OF DIVE ANGLE

When using the altimeter to determine correct release altitude commensurate with the optimum release slant range, variations in dive angle induces a double error in the ordnance impact point, see figure 4-3. Releasing on a given altimeter indication when the dive angle is steeper than optimum also reduces the release slant range. Either condition requires less sight depression and the ordnance overshoots the target. Consequently, releasing on a given altimeter indication in a shallover dive angle than optimum, creates a requirement for greater sight depression than selected to compensate for the decreased dive angle and increased range and the munition will impact short of the intended target. When computing indicated altimeter indications to determine release, it is important to have the altimeter set to the target altimeter setting and to include altimeter lag in the computations.

Figure 4-3 depicts the results of too steep, too shallow, and planned release dive angles for constant and varying altitudes.

Releasing munition at a steeper than optimum dive angle results in the munition overshooting the target due to the lesser sight depression requirement as the release dive angle increases (see figure 4-4). A re-

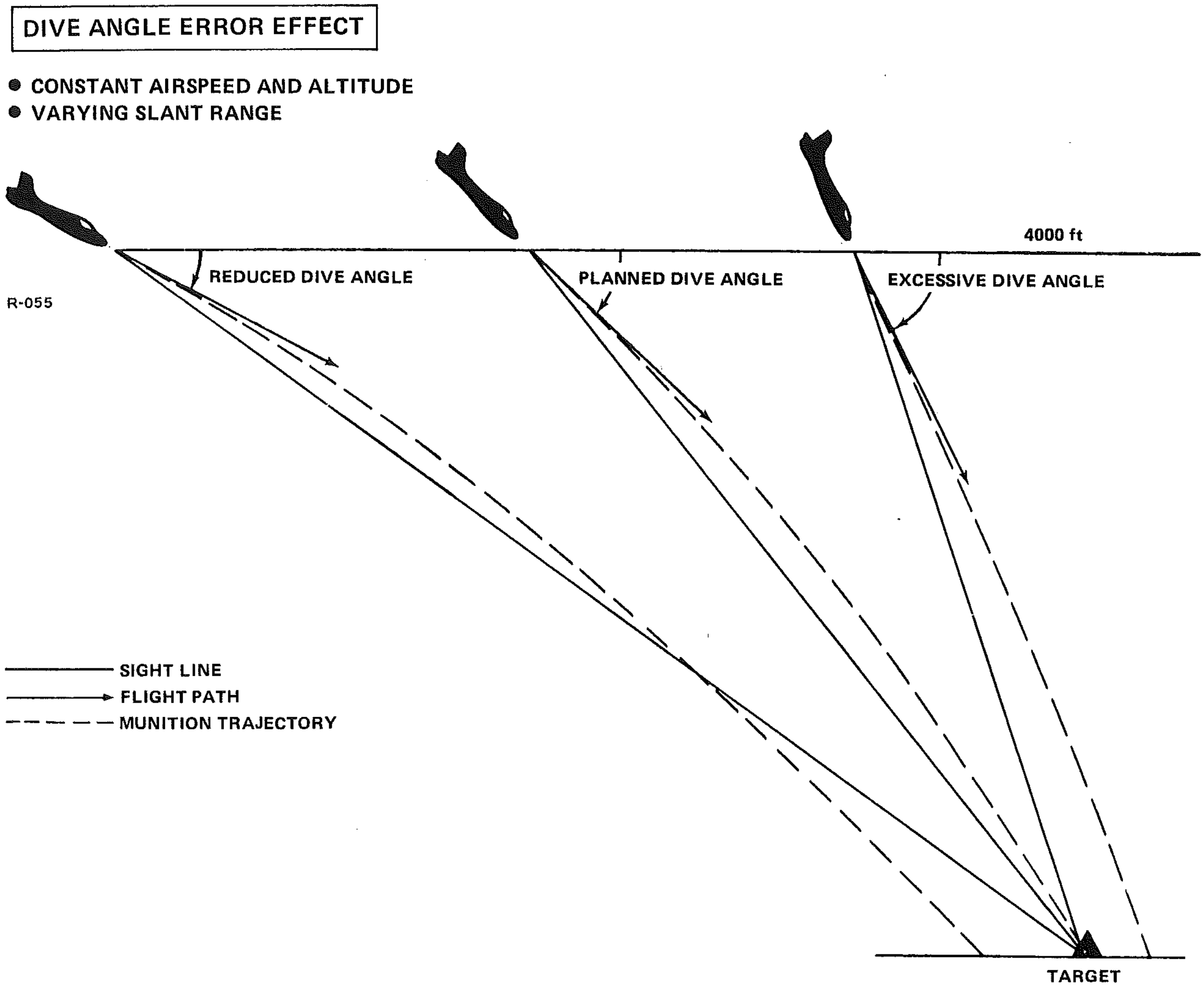


Figure 4-3. (Sheet 1)

duced dive angle from optimum results in the munition impacting short, due to the requirement for a greater sight depression angle at shallower dive angles.

EFFECT OF AIRSPEED

The only velocity imparted to a bomb released from an aircraft is the velocity imparted by the speed of the aircraft at the time of release. Bombs released at a lower airspeed than required by the computed sight setting results in the bomb impacting short of the target and consequently bombs released at a higher than computed airspeed will overshoot the target.
Changes in aircraft airspeed change the angle of attack of the aircraft and will alter the sight depression relative to the flight path of the aircraft. The changed angle of attack will in turn induce an overshoot or undershoot error in impact of the ordnance. This same change in angle of attack of the aircraft will alter the angle of attack of the rocket launcher and muzzles of the guns relative to the flight path of the aircraft. This in turn alters the amount of trajectory shift of the rocket and guns while at the same time imparting a different aircraft release velocity to the projectiles. Rockets are greatly effected by changes in release airspeed from optimum and guns to a lesser degree. An increase in airspeed from the optimum selected one for a given release condition and precomputed sight setting will cause an overshoot for rocket and gun projectiles. An undershoot will occur when the airspeed is less than the optimum one. Figure 4-4 depicts the effect due to deviation from the planned airspeed on munition impact point.

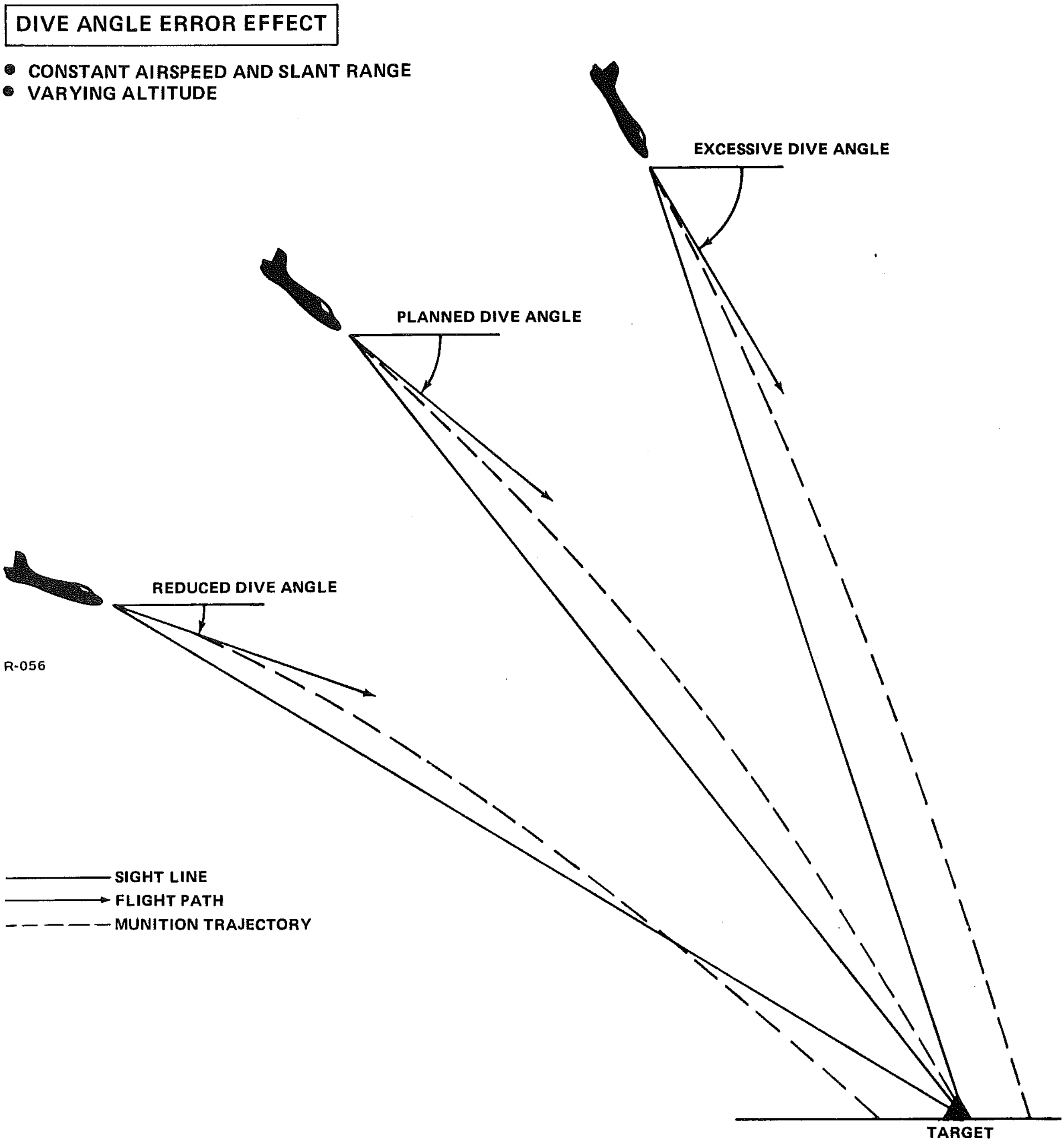


Figure 4-3. (Sheet 2)

EFFECT OF RELEASE ALTITUDE ERROR

Munition released at a higher altitude than planned, resulting in a greater slant range from the target, results in the munition impacting short of the target. Consequently, munitions released at a lower altitude, resulting in a shorter slant range from the target, will overshoot the target. The fallacy of pressing into the target becomes immediately apparent as the relased ordnance will overshoot the target while further exposing the aircraft to the bomb blast and fragmentation envelope. Figure 4-5 depicts the results of higher, lower and planned release altitude for dive and level deliveries.

EFFECT OF SKID ON ORDNANCE IMPACT

Munitions released while the aircraft is flying in a skid causes the impact to occur

AIRSPEED ERROR EFFECT

- CONSTANT ALTITUDE AND DIVE ANGLE

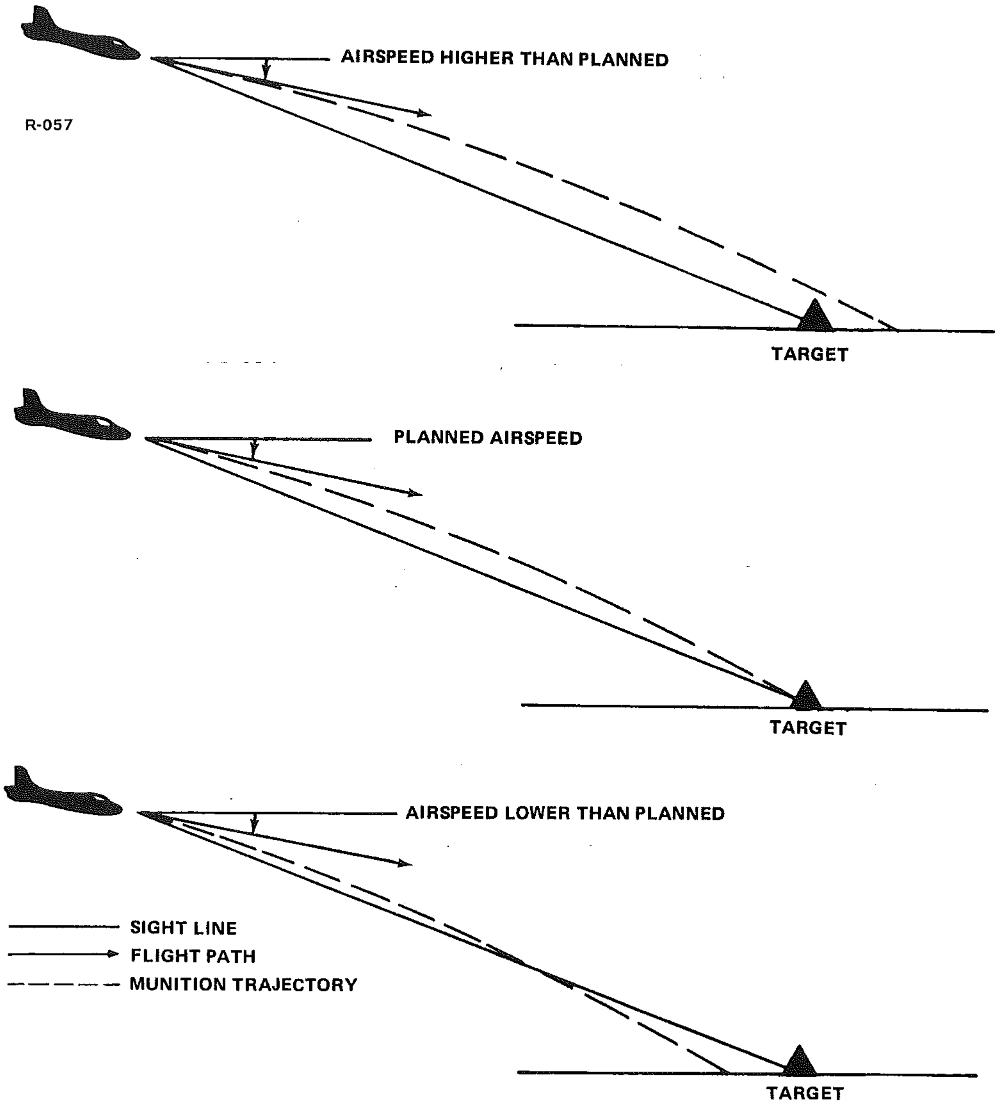


Figure 4-4.

right or left of the target as a result of the cross vector forces acting on the ordnance at the time of release. Right rudder application, in an attempt to hold the sight picture in the target, will cause the ordnance to impact left of the target and conversely left rudder application will cause the ordnance to impact to the right. Bombs are the most effected by skid as bombs will follow the flight of the aircraft and the total error increases in proportion of the release slant range, rockets and guns have their own velocity at release and the resultant forces cause less drift error. The bullet path is the result of the aircraft velocity and muzzle velocity. As the latter is so high when compared with aircraft speed the bullet veers very little from the sight line. The rocket velocity being less, it falls between the bomb and bullet projectile. Figure 4-6 depicts the effect of skid on munition impact point.

EFFECT OF BANK ON SIGHT LINE AND MUNITION IMPACT

Munitions released from the aircraft are immediately effected by gravity and depending on the type of ordnance released and the sight depression will impact right or left of

ALTITUDE ERROR EFFECT

- **CONSTANT AIRSPEED AND DIVE ANGLE**

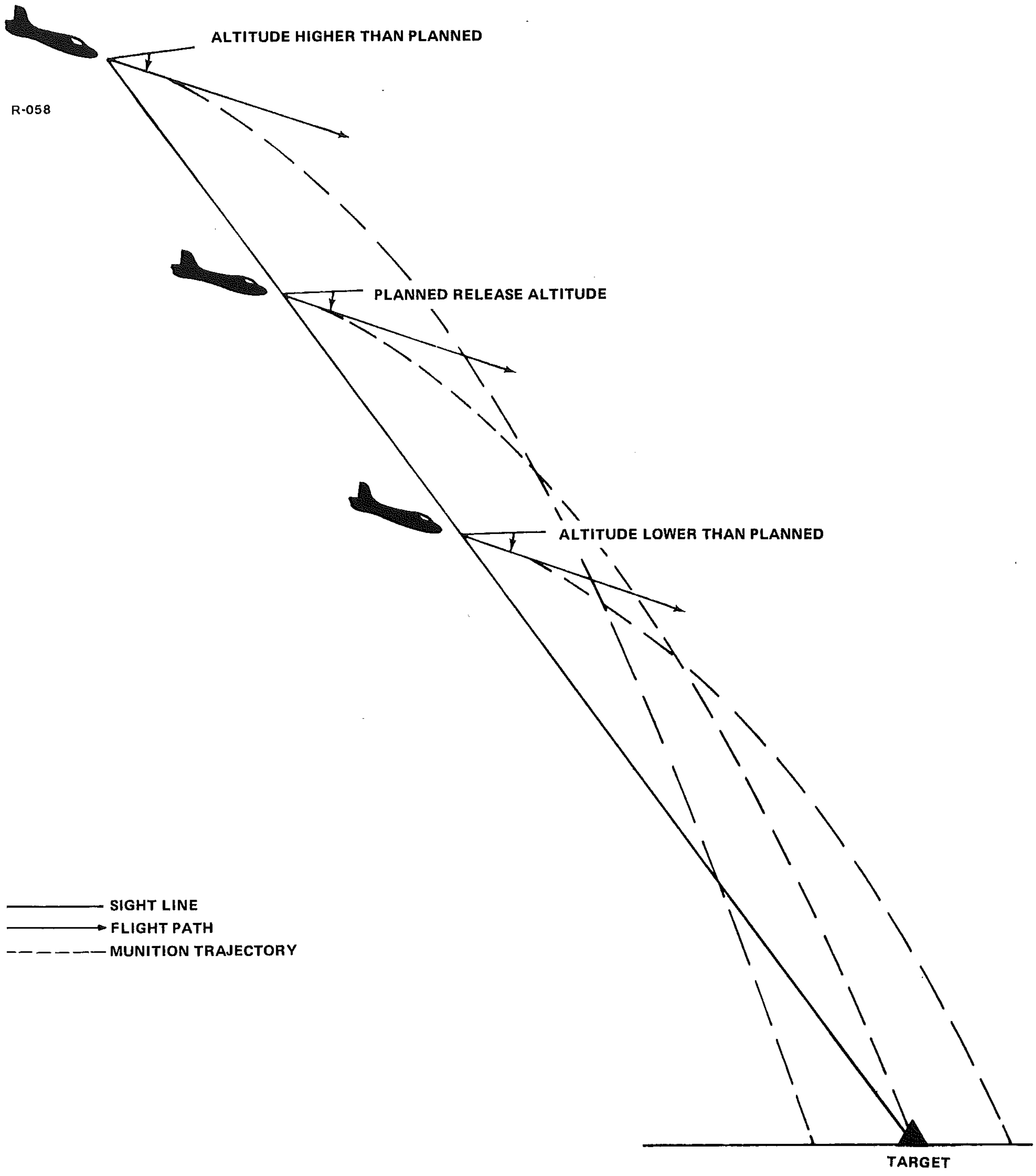
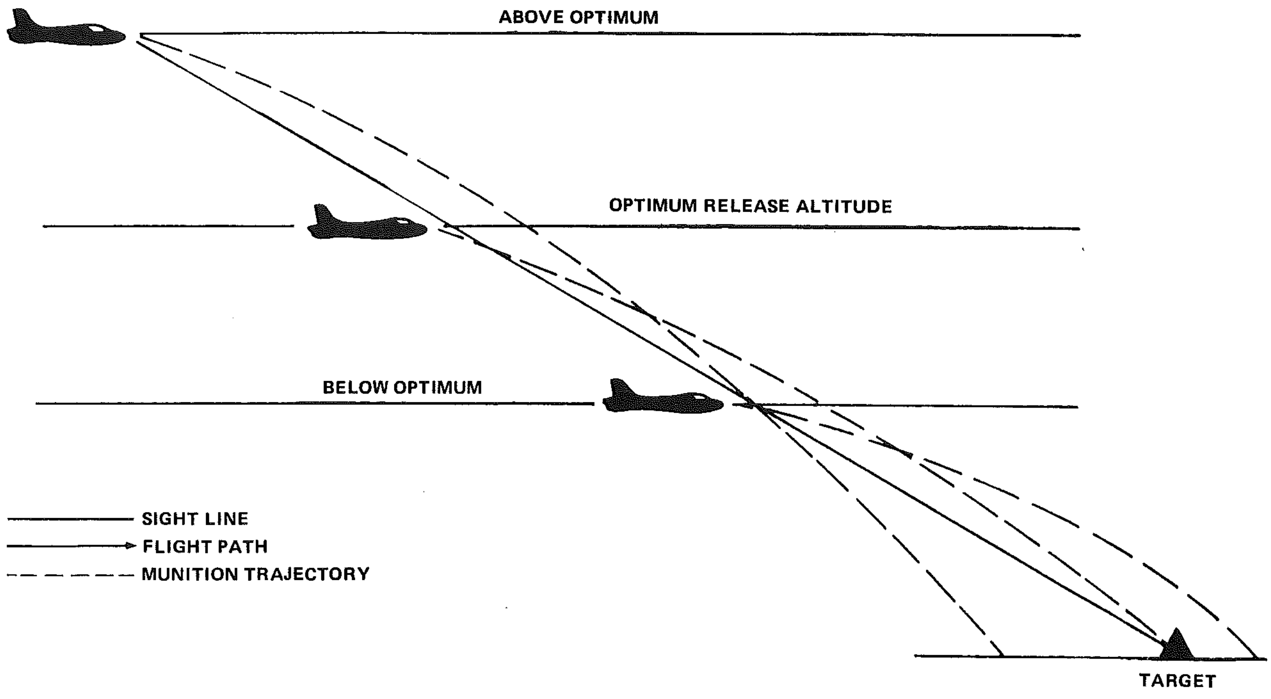


Figure 4-5. (Sheet 1)

ALTITUDE ERROR EFFECT

- **CONSTANT AIRSPEED**



R-061

Figure 4-5. (Sheet 2)

the target, if released while the aircraft is in a bank. See figure 4-7. This will create the greatest error when releasing bombs, as the bomb has the least amount of forward velocity to counteract the force of gravity and requires a greater amount of sight depression which will in turn place the aircraft further right or left of the target at release. Guns are least affected by firing while in a bank. Rocket projectiles have a velocity of their own and are less affected than bombs but more so than guns.
Recognizing the effect of the bank angle on the sight line and bringing the aircraft wings level causes the pendulum effect. The movement becomes more pronounced as the sight line is depressed. Consequently aircraft alignment initiated with the target should be accomplished by reference to the sight line for tracking reference.

EFFECT OF "G" LOADING

Dive bombing ballistic tables are based on a release g-force equal to the cosine of the dive angle (0.866 g at 30° for example). Ordnance released when the aircraft deviates from planned G condition will result in an impact error. See figure 4-8. An increase in g-loading on an aircraft results in an increase in angle of attack which, in effect decreases sight depression relative to the flight path. The result will be an undershoot. Conversely, a negative g-loading will decrease the aircraft angle of attack, thus producing an overshoot. Gun and rocket accuracy is further aggravated by the different than computed trajectory shift caused by the change in the muzzle and launcher angle of attack.

HARMONIZATION

Whenever it is possible to carry out the gun harmonization from 1000 ft distance it is suggested to use this procedure. Use target board Macchi Ref. No. 4920-0064-17. If the harmonization is not possible or not convenient at 1000 in. distance, use the graticule for gun boresighting Macchi Ref. No. 4920-0064-01 at 1000 in. distance (25.4 m) from gun muzzle.

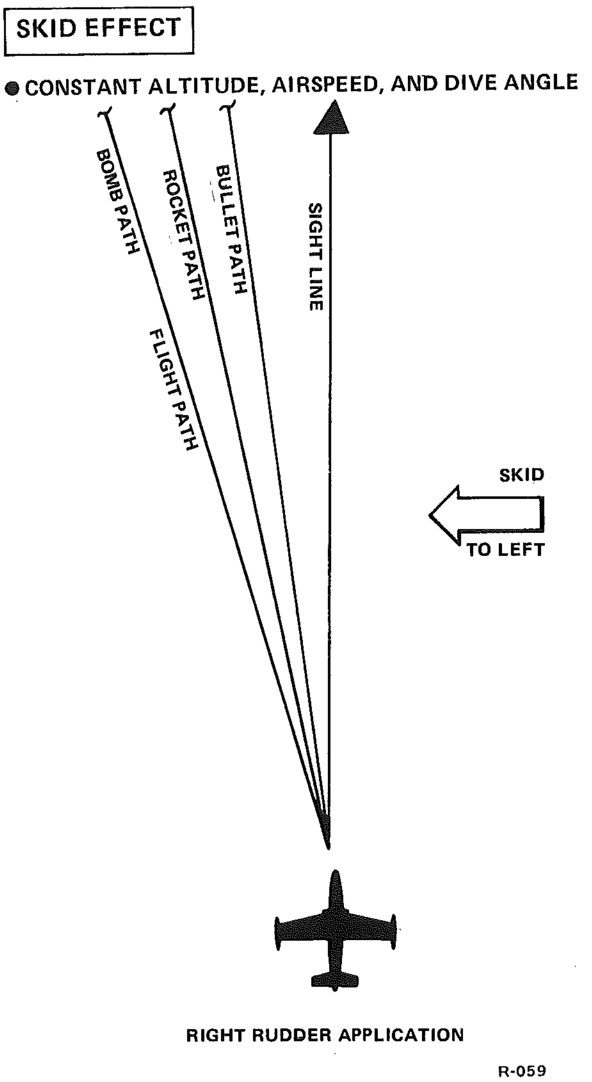


Figure 4-6.

HVAR AND SCAR LAUNCHER HARMONIZATION

HVAR and SCAR rockets are installed on zero length rail and consequently are only slightly affected by a limited displacement of the launcher in relation to the pre-computed position which is 26.2 mils upward respect to FRL (the launcher vertical plane is parallel to the aircraft vertical plane). Considering the above mentioned conditions, it is not required any HVAR and SCAR launcher harmonization.

FFAR, LAUNCHER HARMONIZATION (ANY TYPE)

All launchers, are attached to pylons by means of standard, 14 in. suspension lugs and the launcher vertical plane of symmetry is parallel to the aircraft vertical plane of symmetry (the launchers cannot be adjusted in azimuth). Normally almost all launchers can be adjusted for what concerns the elevation by screwing or unscrewing one or both the suspension lugs.

To perform the harmonization in azimuth it is necessary to insert into the rocket tube nearest to the launcher centre the prescribed device. It is made up by a tube (having a diameter equal to that of the rocket) provided at the rear end by a sighting hole (eyepiece) and at the front end of an alignment cross-hair. See figure 4-10. By sighting from the hole through the cross to the target board type Aermacchi 4920-0064-17 situated at 1000 ft distance and lined up with the aircraft, according to

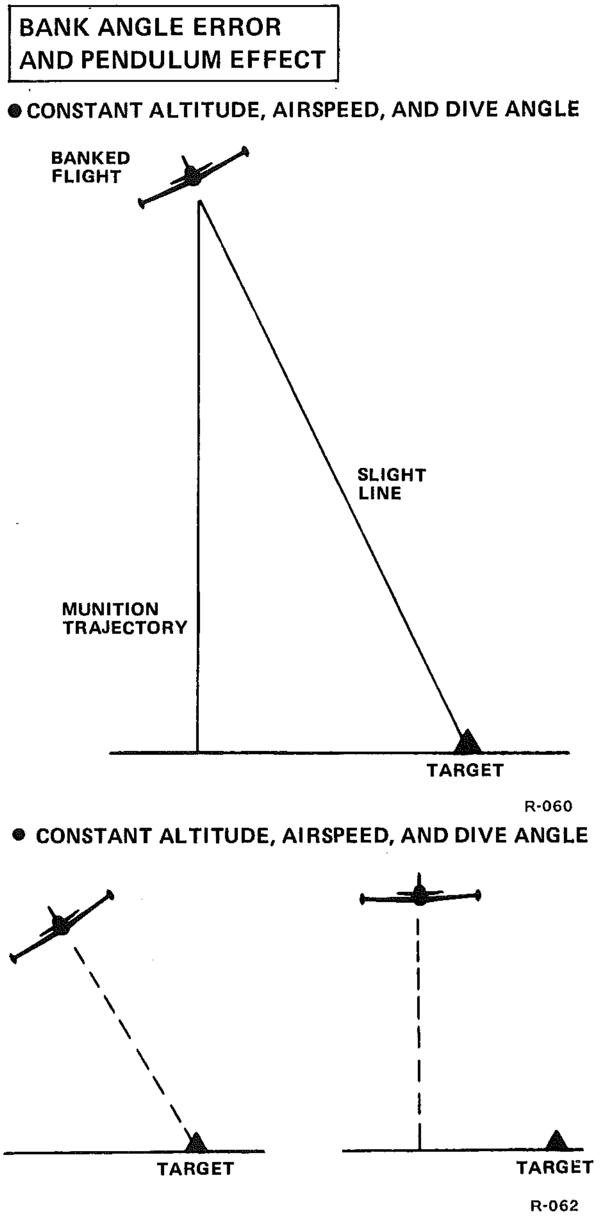


Figure 4-7.

G-LOAD ERROR EFFECT

- CONSTANT AIRSPEED AND ALTITUDE

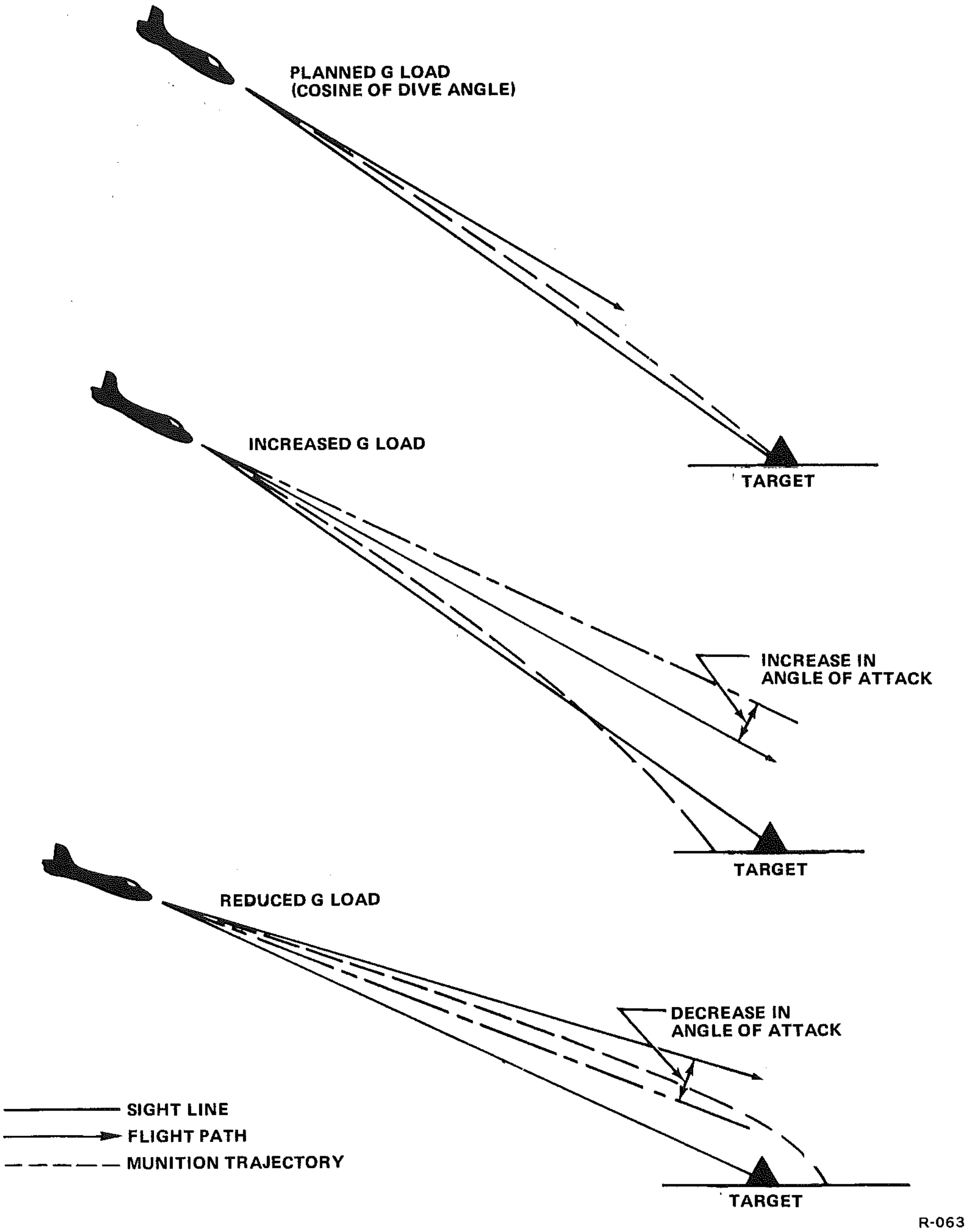
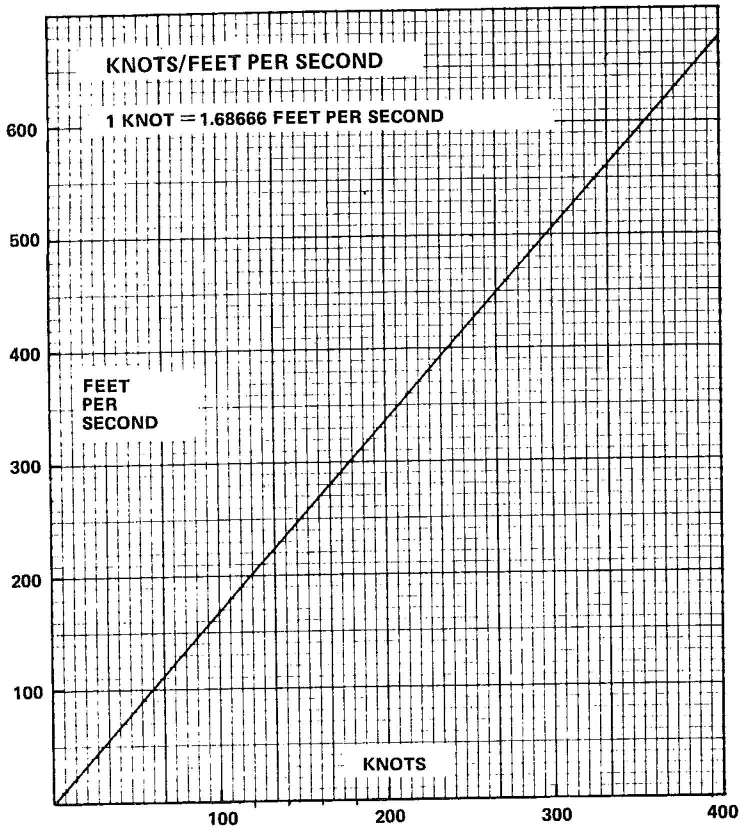
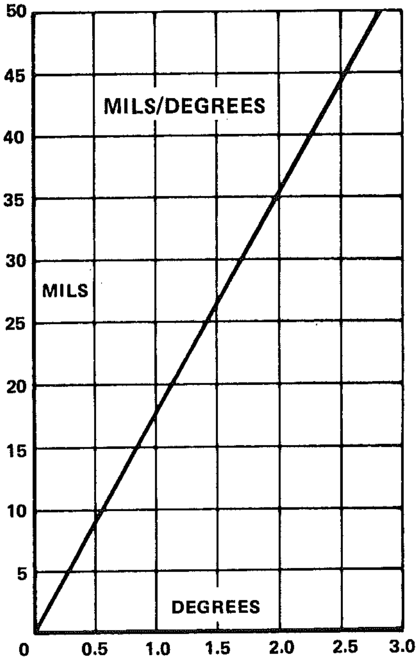
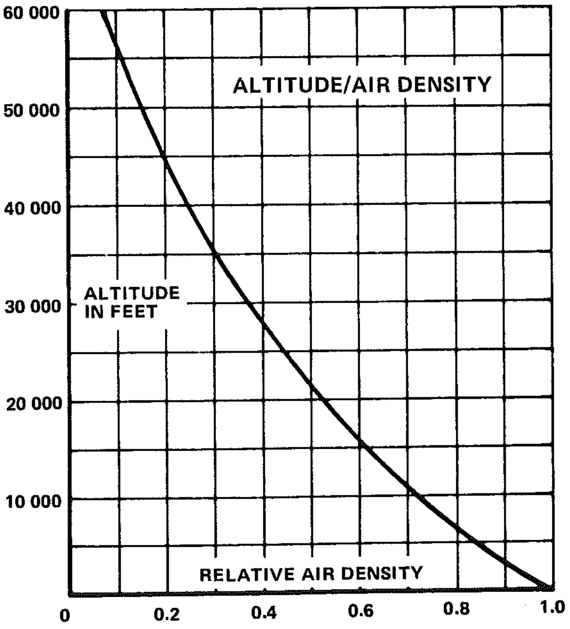


Figure 4-8.

CONVERSION CHARTS







SPEED CONVERSION

MPH	KNOTS	KM/H
50	43	80
100	87	161
125	109	201
150	130	241
175	152	281
200	174	322
225	195	362
250	217	402
300	261	483
350	304	563
400	347	644
500	434	805
600	521	966
700	608	1127

R-064

Figure 4-9.

the procedures described in the applicable Maintenance Manual, the horizontal alignment of the centre of the gun boresighting point must be obtained.

NOTE

The gunsight must be adjusted to aim the bulls-eye when 6.3 mils depressed.

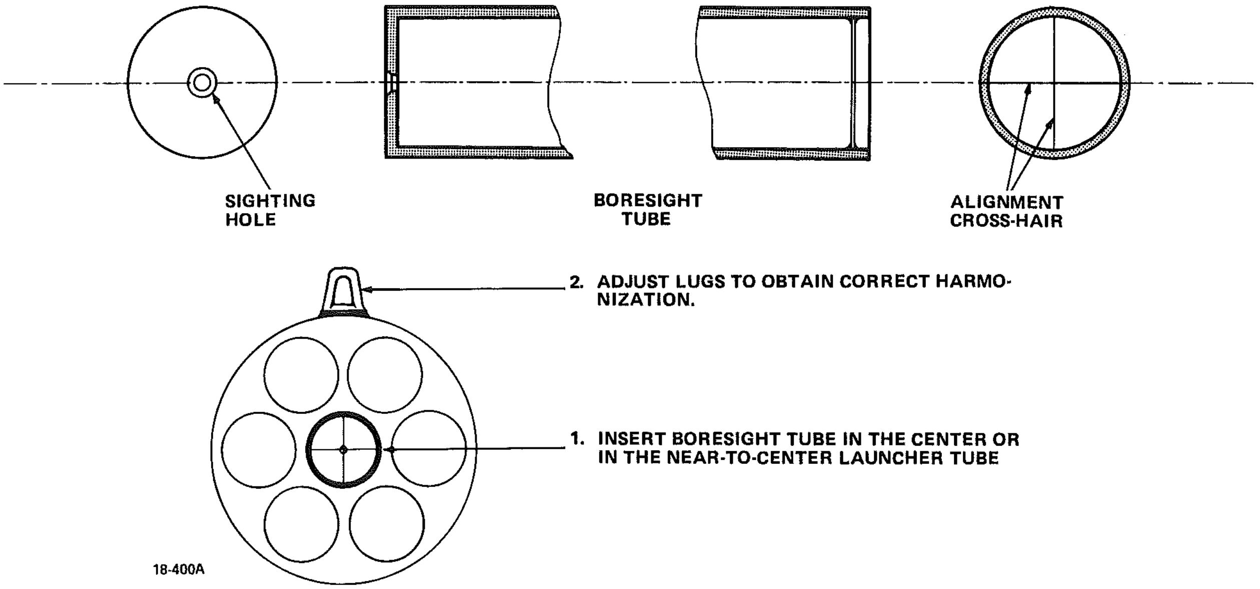
This is obtained by screwing or unscrewing one or both suspension lugs.

CAUTION

Safety lock suspension lugs after the harmonization is performed.

Figure 4-10. shows the sight picture obtained when properly sighting through the boresight tube on a harmonization target which is at a range of 1000 ft.

ROCKET LAUNCHER BORESIGHT


SIGHTING HOLE
BORESIGHT TUBE
ALIGNMENT CROSS-HAIR
2. ADJUST LUGS TO OBTAIN CORRECT HARMONIZATION.
1. INSERT BORESIGHT TUBE IN THE CENTER OR IN THE NEAR-TO-CENTER LAUNCHER TUBE
18-400A

SIGHTING THE HARMONIZATION TARGET THROUGH THE BORESIGHT TUBE

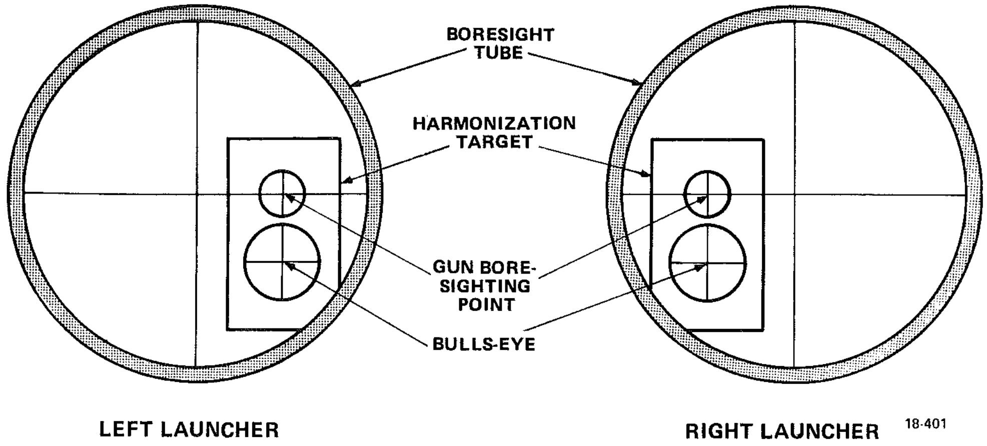


Figure 4-10.

A6B TOW TARGET

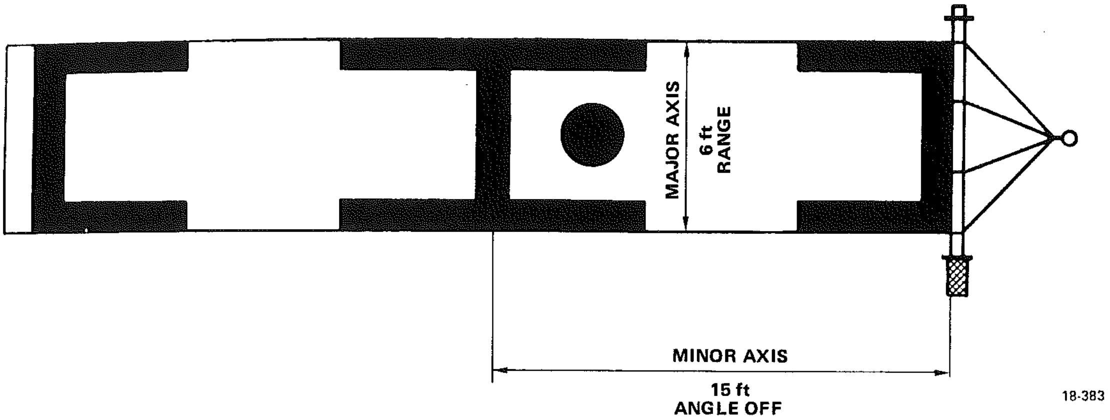


Figure 4-11.

FILM ASSESSING

INTRODUCTION

A conscientious assessing program will result in consistently higher gunnery scores, better trained and more proficient aircrews, higher sight in commission rates, and, most important, maximum benefit from each firing and bombing event.

The well-informed pilot uses the gun camera to determine errors in firing range, slant range, dive angle, alignment with the target, and offset release aiming point. During combat, either aerial or ground attack, the gun camera often provides the only method of recording the destruction inflicted by the fighter. Through proper interpretation or assessment of the film taken by airplane cameras, methods of subsequent attack and vulnerable points of enemy targets can be determined. Proper assessment is an invaluable tool for improving proficiency as well as providing intelligence information.

Procedures are included for determination of range, angle-off, and/or dive angle, assessing equipment and chart construction. Descriptions of the various gun cameras and their specific characteristics are not included, since guidance for their operation is supplied in applicable Flight Manuals.

ASSESSING AERIAL ATTACK FILM

To assess accuracy of attack against aerial target, the pilot must evaluate three things: range, angle-off, and line error. The procedures for determining these items are in the following paragraphs.

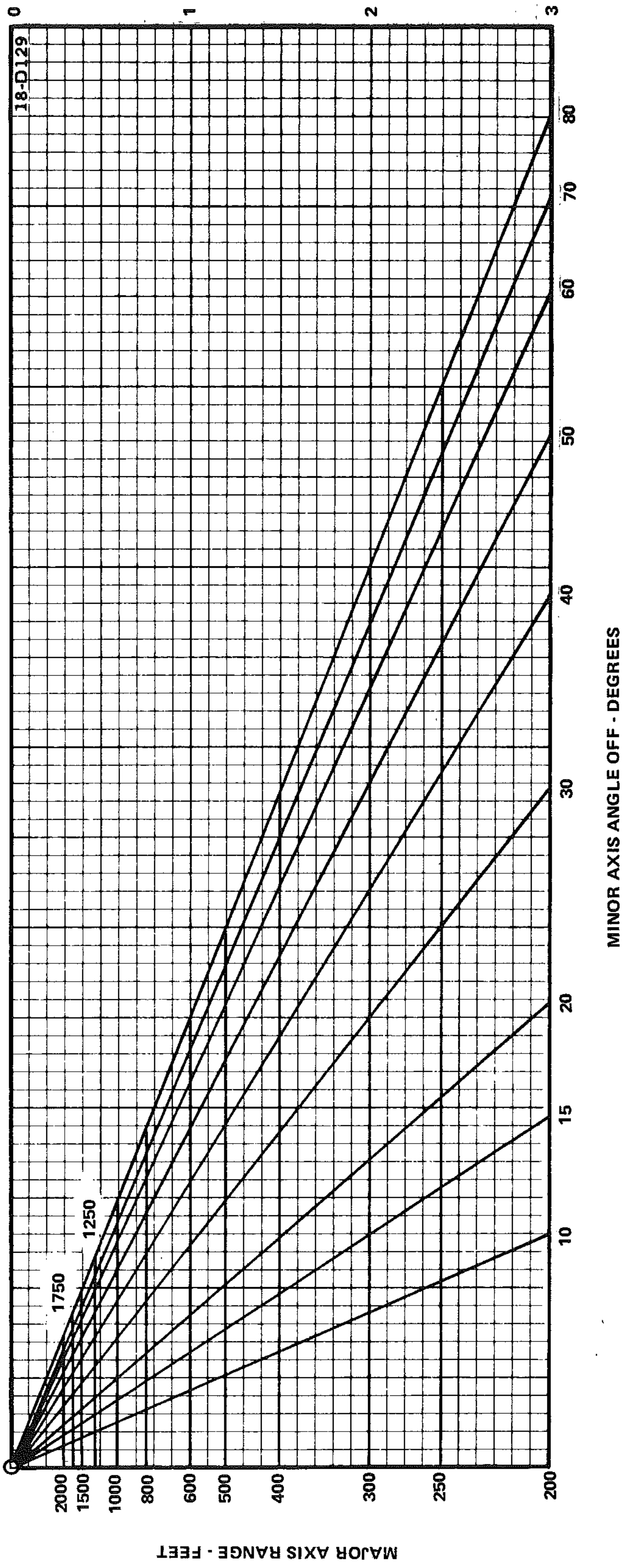
Range

Run the film until the first firing frame of the gunnery pass appears. Using calipers, transfer the width of the target image to the aerial attack estimate assessing chart for the type of lens and size of target being used. Lay this width down the vertical axis of the chart from the baseline. See figure 4-12. Compare this assessed range with the desired firing range and note findings.

Angle-off

Two methods are commonly used to measure and assess angle-off. In one method, the observable length of the target is measured and this measurement is applied to the assessment chart. The other method involves measurement of a known distance on the target. Again, the measurement is applied to the appropriate assessing chart. Either method is satisfactory. The one to be used should be determined by the fighter weapons officer after considering target size, definition of film, and personal preference. After an assessing chart has been constructed for use with the chosen method, use calipers to measure the foreshortened target dimension. Lay this distance off on the horizontal axis of the chart, with one point of the calipers on the vertical axis at the range figure as previously determined. The other point of the calipers will then fall on or between the angle-off lines which emanate from a point at the maximum range of the chart. Interpolation between these radial lines gives the angle-off.

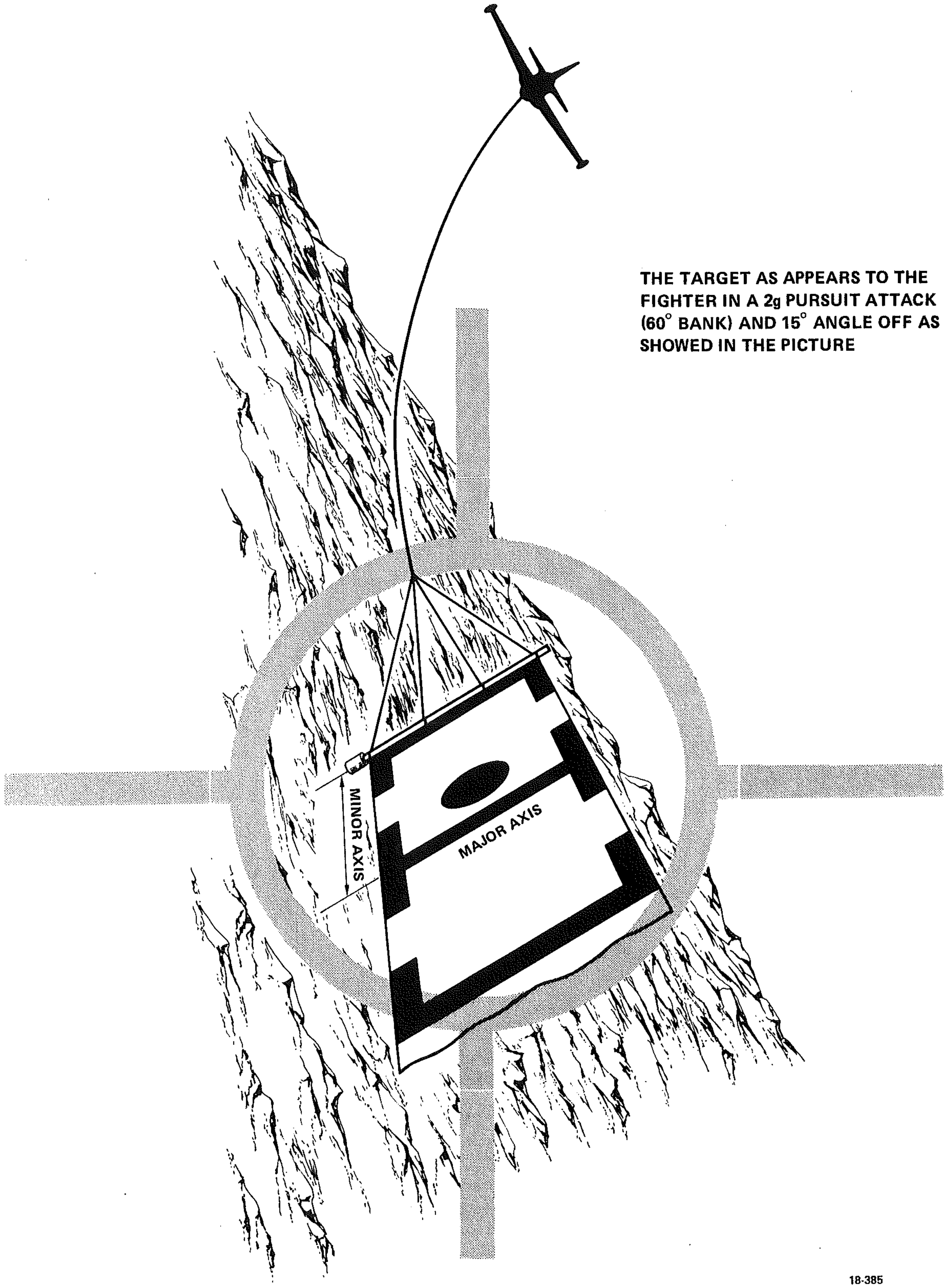
AERIAL ATTACK ASSESSING CHART - A6B TARGET



VALID ONLY FOR IMAGE SCALE OF 10 MILS PER INCH

Figure 4-12.

A6B TARGET VIEW



THE TARGET AS APPEARS TO THE FIGHTER IN A 2g PURSUIT ATTACK (60° BANK) AND 15° ANGLE OFF AS SHOWED IN THE PICTURE

Figure 4-13.

Line Error

The distance, in mils, which the pipper is displaced from the aiming point on the target is known as line error.
This distance is found by measuring the distance, in inches, between the aiming point on the target and the pipper. The line error is this measurement read in mils (1 in. equals 10 mils). Therefore, 1 in. of the pipper displacement would equal about 10 ft of impact error at 1000-foot slant range. Repeat the process at each 2 frame interval.

SUMMARY

If more than one firing pass is performed, note assessment information for range, angle-off, and line error for each pass and compare the results. Usually one or more consistent discrepancies will become evident. Repeated correlation between studied discrepancies in the assessment room and the in-flight attack will quickly achieve the desired objective: consistency of range, angle-off, and sight picture in the aerial attack.

OTHER USES OF ASSESSING CHARTS

Increased emphasis on gun-camera use in simulated attacks against other airplanes has generated a need for a standard measurable index to be used in assessing film obtained on those missions. A study of airplanes can determine which airplane features are suitable for this purpose. For a bomber, the fuselage diameter is determined to be a satisfactory range index. However, the vertical stabilizer of fighter airplanes is found to be a more suitable reference in level attacks during which both the fighter and the target airplanes are in the same plane of reference. With high-side and low-side attacks, the foreshortening effect makes the stabilizer an unreliable index, thus making it necessary to develop special charts for specific attacks. See figure 4-19. If attacks are made in the vertical plane on fighter, unit fighter weapons officers can apply formula to construct valid assessing charts.

NOTE

It is possible to select on the target aircraft (see figure 4-14) a 6 ft vertical structure and a 15 ft horizontal structure in order to have the major axis and minor axis of the target aircraft of dimensions equal to those of the A6B banner-target. Consequently the aerial attack assessing charts (figure 4-12) concerning the banner target can be also used for the target aircraft.

ASSESSING GROUND ATTACK FILM

WARNING

Dive bombing or air-to-ground rocket deliveries requires an immediate pull-up

AERIAL TARGET

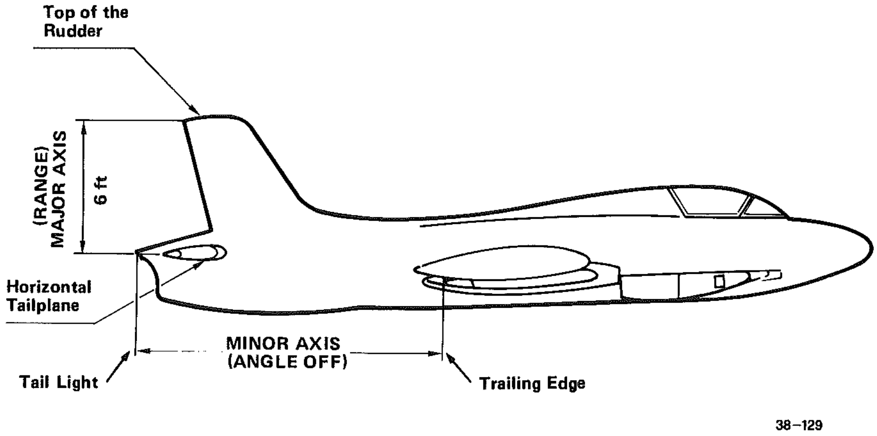


Figure 4-14.

after the release and therefore it is not possible to film assess the weapon hit on the ground. Nevertheless it is always possible to assess the pipper position with respect to target, (line error) the target size, and the dive angle also, at the moment of weapon release. This happens automatically when releasing rockets or bombs.

NOTE

Only the first frame is valid for assessing.

Assessing film of dive-bombing or rocket deliveries requires a knowledge of the target's size and a comparison of its size to the dimensions of the assessed image on an assessing chart. The ground attack assessing chart is constructed with a known proportional relationship to the target's size, thereby permitting determination of the airplane dive angle and firing slant range.

ASSESSING GROUND ATTACK FILM

The procedures for determining these items are in the following paragraphs.

Run film through the projector until the opening frame of the pass appears. With calipers, measure the major axis - the axis of the target circle perpendicular to the diving airplane path over the ground. See figure 4-15. Lay this measurement off along the horizontal axis of the ground attack assessing chart (designed for use with a camera lens of a specified focal length and for a target of a specified size). This reading gives the slant range in feet. See figure 4-16. Measure the minor axis - the axis of the target parallel to the diving airplane's path over the ground. Transfer this measurement to the vertical axis of the ground attack assessing chart. Place one point of the calipers on the vertical axis at the range figure as previously determined. The other point of the calipers will then fall on or between the angle-off lines which emanate from a point at the maximum range of the chart. Interpolation between the diverging dive-angle lines gives the dive angle in degrees.

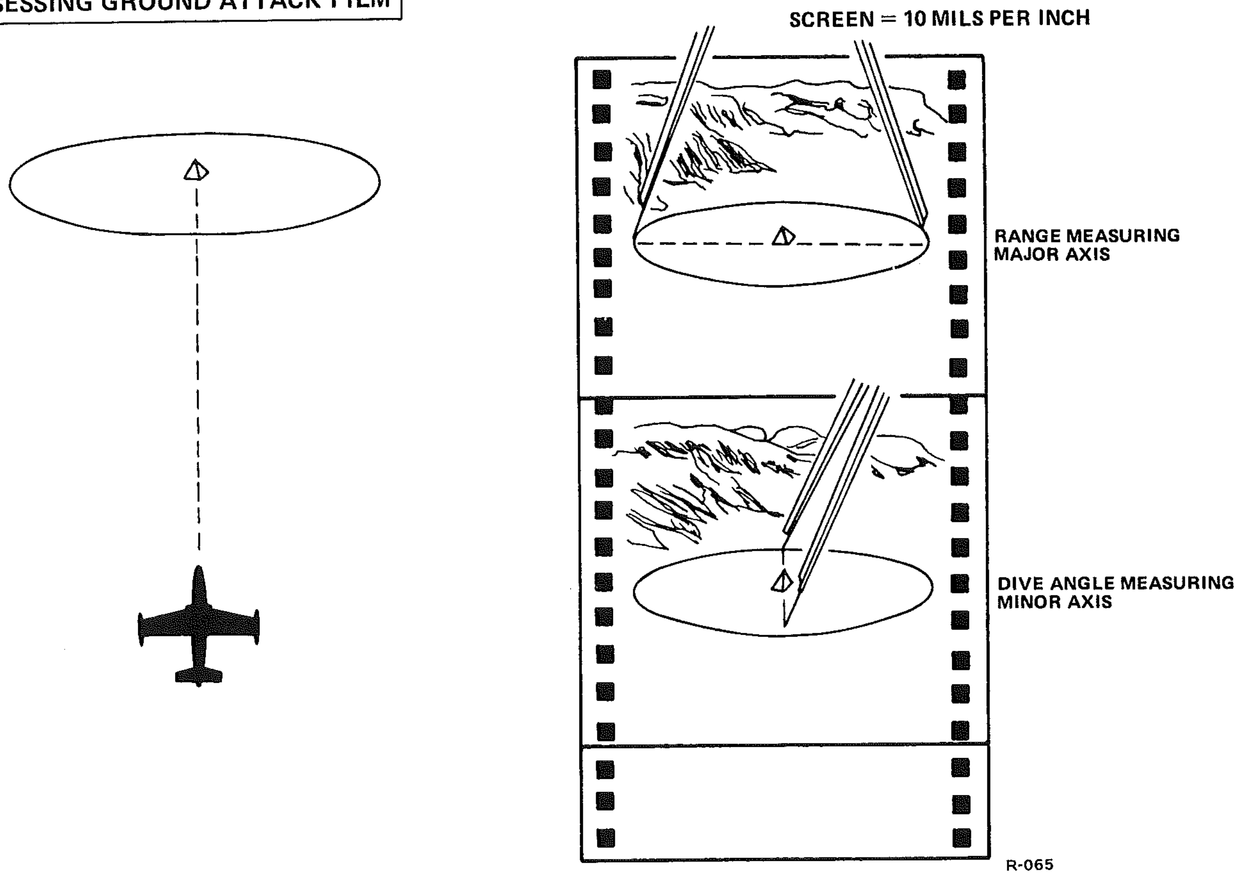
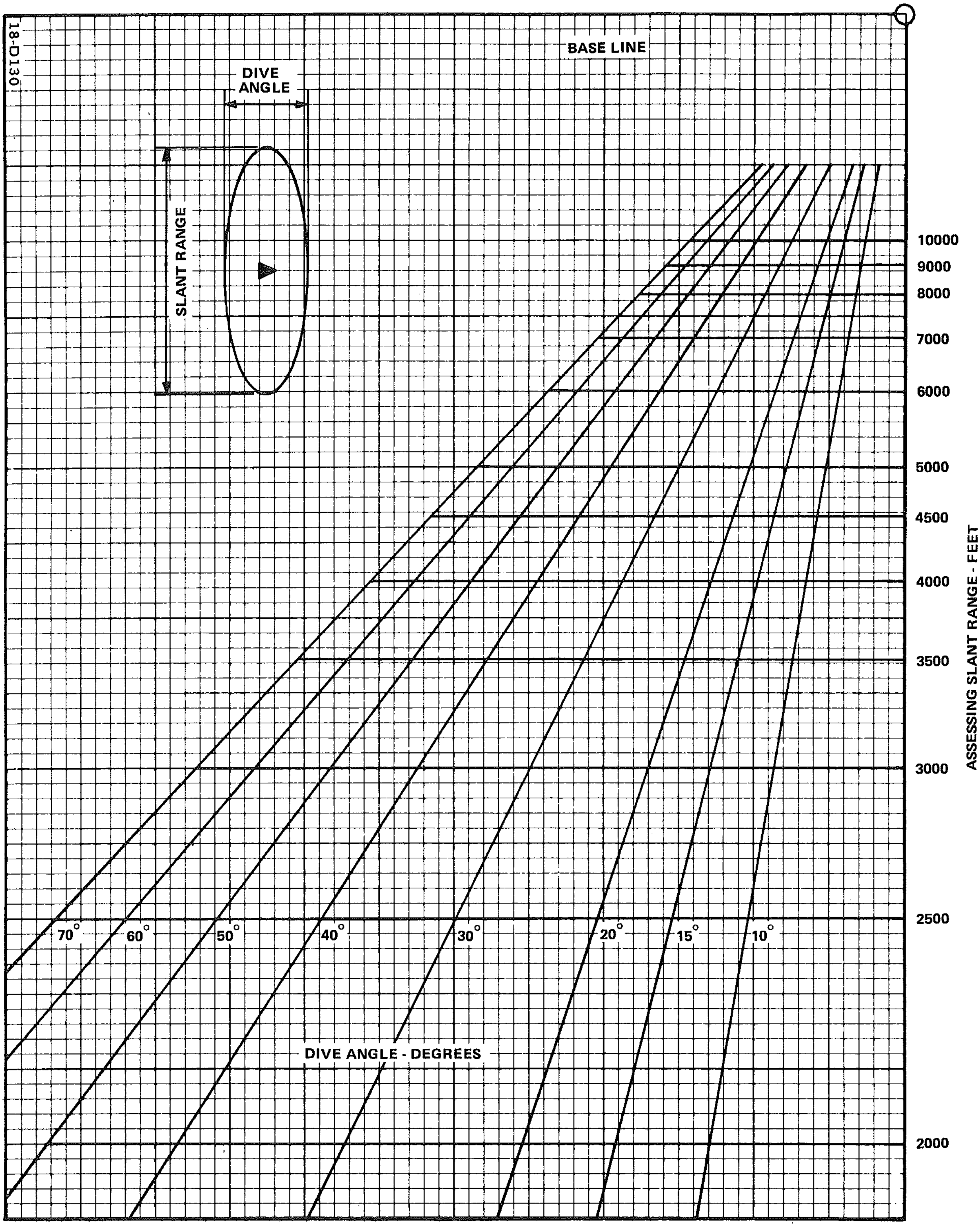

SCREEN = 10 MILS PER INCH
RANGE MEASURING MAJOR AXIS
DIVE ANGLE MEASURING MINOR AXIS
R-065

Figure 4-15.

ASSESSING GROUND ATTACK CHART

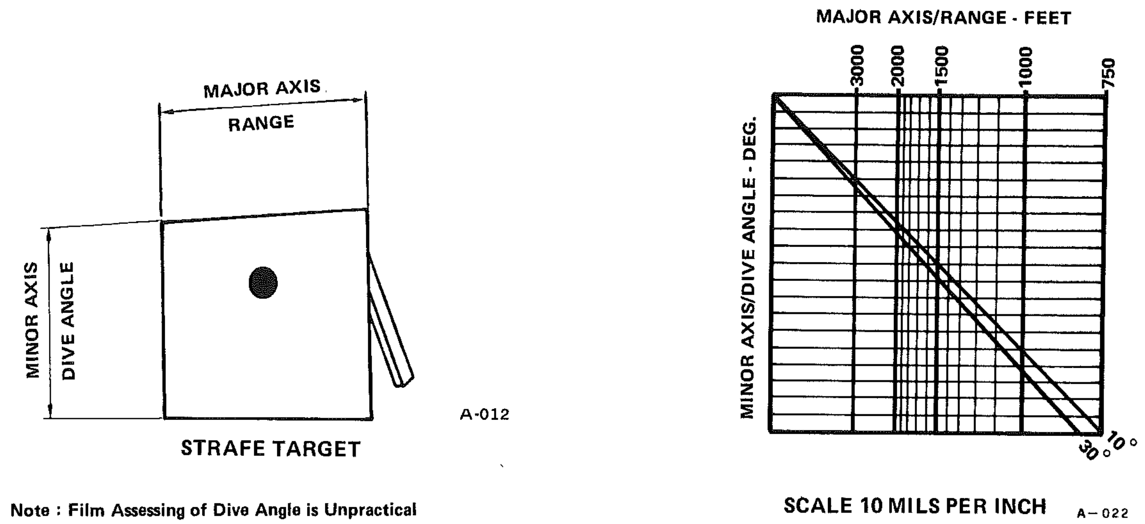


- This graph drawn to scale 10 mils per inch
- Diameter of the target circle 150 ft

SCALE 10 MILS PER INCH

Figure 4-16.

ASSESSING GROUND ATTACK CHART LOW ANGLE STRAFING



Note : Film Assessing of Dive Angle is Unpractical

Figure 4-17.

FILM ASSESSMENT, FIGHTER VS AIRCRAFT MISSION

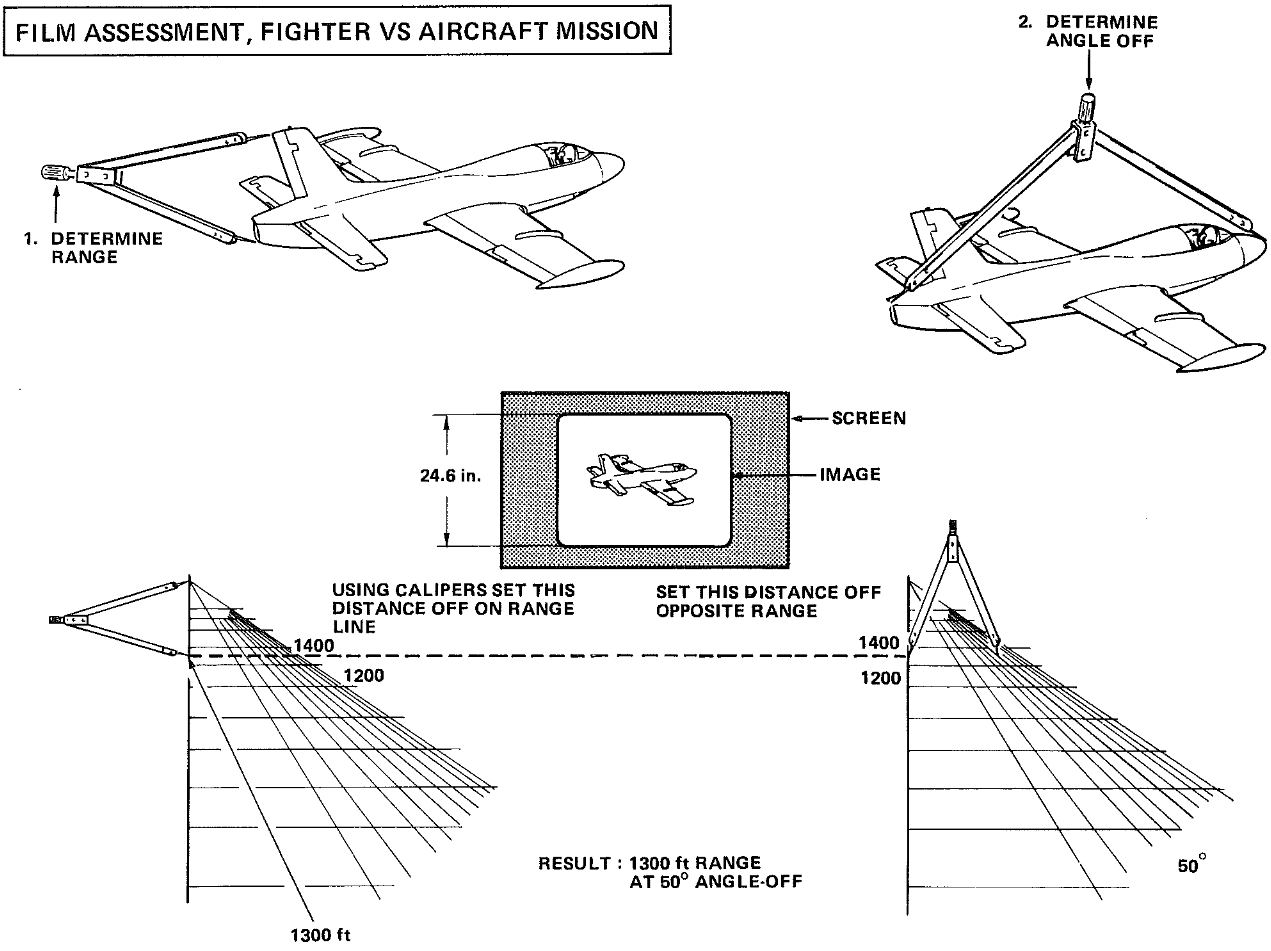

2. DETERMINE ANGLE OFF
1. DETERMINE RANGE
SCREEN
IMAGE
24.6 in.
USING CALIPERS SET THIS DISTANCE OFF ON RANGE LINE
SET THIS DISTANCE OFF OPPOSITE RANGE
1400
1200
1400
1200
RESULT : 1300 ft RANGE AT 50° ANGLE-OFF
50°
1300 ft

Figure 4-18.

ASSESSING ROOM EQUIPMENT

The film assessing room should include the following equipment:

a. 16 mm motion picture projector.

b. Assessing table or workbench upon which to mount the projector.

c. Projector screen.

d. Calipers.

e. Film reels.

f. Film rack storage.

g. Film assessing charts.

h. Magazine titling assembly, locally manufactured from a standard gun camera.

ASSESSING CHART CONSTRUCTION

This paragraph deals primarily with construction of assessing charts for the 30.4 mm lens (procedures and formulas outlined are applicable to any gun camera lens, but it is necessary to substitute different values for the angle of projection of other lenses and target sizes). Charts presently in use are designed for a projection image with a scale of 10 mils per inch (although larger images would tend to promote accuracy in using the chart, poor film quality produces unacceptably poor target definition). Since the angular projection of the 20.4 mm lens is 247 mils, the arbitrarily selected scale of 10 mils per inch requires that the projector be positioned to achieve a projected frame or image 24.6-inch in height. After this determination, charts are constructed to scale, thus permitting a direct transfer of measurement from the projected image on the screen to the assessing chart (distance from lens to screen is 49.2 in.). See figure 4-19. Computation for chart construction is accomplished in three steps (the third step is used only when angle-off or dive angle must be determined):

1. Determine target size, in mils, for a specified range. This may be accomplished by substituting into the formula:

$$\frac{\text{Target dimension x 1000}}{\text{Range}} =$$

$$= \text{Target size in mils}$$

2. Convert target size, in mils, to width in inches. To do this, substitute into the formula:

$$\frac{\text{Target size in mils}}{\text{Mils per inch on screen}} =$$

$$= \text{Width in inches on the screen}$$

ASSESSING EQUIPMENT GENERAL LAYOUT

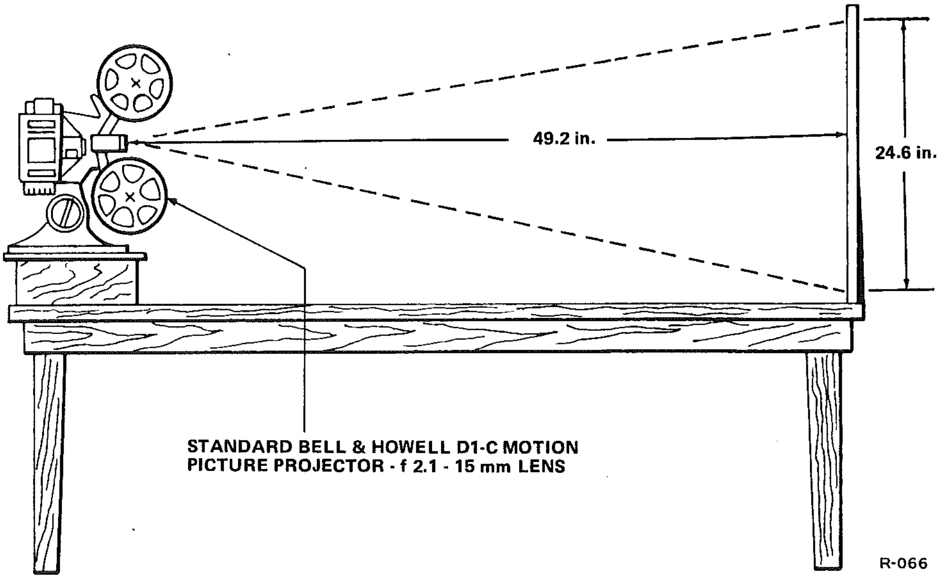

49.2 in.
24.6 in.
STANDARD BELL & HOWELL D1-C MOTION PICTURE PROJECTOR - f 2.1 - 15 mm LENS
R-066

Figure 4-19.

3. Determine length of the minor axis of the aerial target, bombing circle, or strafe panel, in inches, for the specified range and dive angle. Substitute into the formula:

$$\frac{\text{Target size in mils x Sine of dive angle}}{\text{Mils per inch on scren}} =$$

$$= \text{Minor axis in inches}$$

To perform necessary computation and construct an A6B assessing chart, use 6 feet as the target dimension and appropriate selected range. Substitute into the formula in step 1 to determine target size, in mils, for the selected ranges.

At the greater ranges, this chart is likely to produce major errors in measurement because of poor target definition and proximity of the range lines on the chart. Since 10 mils represents 1 in. on the screen, (divide mil-values by 10 to complete step 2). The chart can now be constructed with all measurements taken from the baseline. When film assessing charts are constructed for aerial combat targets, complete step 3. For angle-off measurement, the dimension of a given portion of the fuselage length is the appropriate target length. The size of the portion used will depend upon the type of airplane photographed. (See aerial target in figure 4-14).

To construct a dive bomb chart, use the same procedure to determine range lines; then substitute into the formula for step 3 to compute the length of the minor axis of the bombing circle for various dive angle. Although it will be necessary to compute these for only one selected range (range has a proportional relationship to dive angle), it is wise to check accuracy of work by computing dive angles for at least three ranges. In the construction phase, measurements for fixing the position of range lines must be taken from the baseline. After range lines have been drawn (as shown in figure 4-17) determine the points of intersection and draw in the dive-angle lines as shown (measurements will be made from the vertical line). The completed chart is shown in figure 4-16.

With chart computation accomplished and the assessing room organized, the role of the weapons officer in the film assessing program is only partially complete. For the film assessing program to be effective, record must be kept of all film taken and assessed. If this is done and film is assessed conscientiously, you can expect to receive a bonus of improved scores and greater overall effectiveness.

NOTE

By using a camera gun with a focal distance f = 30.4 mm (1/10 ft) and for the projection a motion picture projector having a focal distance f = 15 mm the results are as follows:

- On the photogram 1 mil is equal to 1/10 000 ft = 0.0304 mm.
- On the projection 1 mil is a function of the distance D from the screen to the projector lens (that is to say the magnification ratio of the system) which is I = D:f, where f = projector focal distance, in this case 15 mm (D1-C projector). To obtain 10 mils, which are represented by 1 inch, on the screen is necessary to magnify of I = 1/0.304 inch will be

$$I = \frac{1''}{12''/1000} = \frac{1000}{12} =$$

$$= 83.33$$

With f = 15 mm the distance of the screen from the lens will be, in millimeter:

$$D = I \times f = \frac{1000}{12} \times$$

$$15 = \frac{15000}{12} = 1250 \text{ mm} =$$

$$= 49.2 \text{ in.}$$

The photogram of OMERA SEGID camera type 20 has the dimension of 7.5 x 10 mm. Check, on the screen, that the dimensions of the photogram are 655 x 833 mm (24.6 x 32.8 in.).

RANGE SPECIFICATIONS AND PROCEDURES

To become proficient in all phases of fighter weapons delivery, fighter pilots must make controlled attacks on scorable targets. This training should be conducted as frequently as possible. Close supervision in this phase of training is mandatory and can be accomplished if strict aerial discipline is maintained.

This chapter deals with the targets and

their arrangement on the various type of ranges. The range procedures, safety precautions, and scoring procedures are explained.

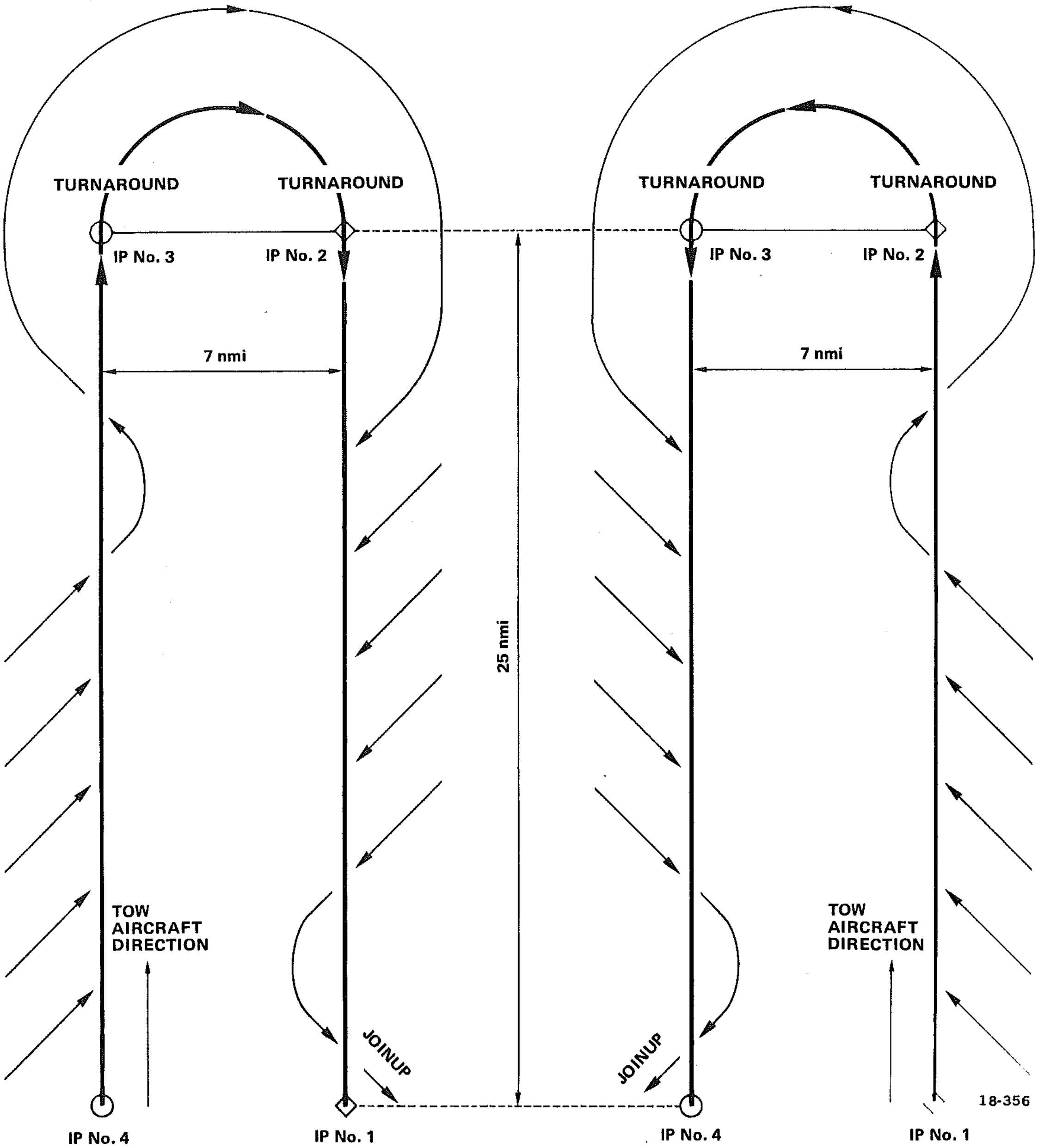
In general the material supplements the detailed information on planning, construction, operation and maintenance of bombing and gunnery ranges as covered in local Air Force Regulations and Specifications.

The types described here include air-to-air, low angle strafing, skip bombing, dive bombing and rocket firing, and consolidated air-to-ground ranges.

AIR-TO-AIR RANGE

An air-to-air range is a designated airspace reservation above an uninhabited land or water area. This reservation must of necessity be rather large because of the range

TYPICAL AIR-TO-AIR RANGE



ALL PATTERNS ORIGINATING AT IP No. 4 WILL UTILIZE LEFT HAND PASSES

ALL PATTERNS ORIGINATING AT IP No. 1 WILL UTILIZE RIGHT HAND PASSES

Figure 4-20.

and striking power of the projectiles fired by fighter aircraft. For example, if a target is towed at an indicated airspeed of 165 to 180 kt, the average range should be a minimum of 25-mile long and 7-mile wide. A tipical air-to-air range is shown in the figure 4-20.
The range may be identified either by prominent landmarks or by range markers easily wisible form the air.

Safety Precautions

Safety measures will be obeyed in accordance with the provisions of local Air Force Regulations.
Air-to-air passes on a towed target will terminate at a minimum of 600 ft range, or 15° angle-off whichever occurs first.
Firing will not be conducted when weather conditons are such that the pilot of the two aircraft cannot determine the range boundaries, unless adequate means, such as radar coverage, have been established and approved at major command level to insure that the range is clear and participating aircraft are within the boundaries of the range.
The commander should issue timely warning through local press and radio to prevent uniformed persons from trespassing on the range during periods that training is in progress. When the range is not in continuous use throughout the year, the commander should notify the Air Force responsible agencies, and commanders of nearby military and naval installations, Civil Aviation Agencies and corresponding maritime organizations, to preclude aircraft, or shipping as in the case of overwater target areas, from trespasssing during firing periods. The range will be declared a danger area during firing periods.
After completion of firing and prior to landing, pilots will turn off all armament switches, and comply with local safety regulations.
Under no circumstances will a pilot fire on a closed range, or when he has negative radio contact with all other members of the flight and the tow aircraft.
Commanders will issue such local rules and regulations as are necessary to prohibit aircraft carrying live ammunition from flying over any area where accidental discharge or release of the ammunition might cause damage to government or private property, or endanger life.
Unit commanders must be sure that all personnel towing targets or firing on the range are thoroughly familiar with all range rules and procedures. It will be the responsibility of the unit commander to see that these rules and procedures are stricly enforced.

Flight Pattern

Aircraft equipped with aerial machine guns will utilize the standard 90° high-side type pass when firing at towed targets. This pass may be initiated from the right or left side of the target, depending upon the direction of the bullet travel. The air-to-air pattern on any target will contain a maximum of four aircraft at any time.
The Air-to-Air Pattern is explained in para. "Air-to-air range procedures".

AIR-TO-GROUND RANGES

The selection of a site for a ground attack range requires that a maximum safety limit be maintained in order to protect personnel and equipment. It must be clear of obstructions and should be isolated by a minimum distance of 2 mi from all other installations. If other than practice ammunition, rockets, and bombs are to be used the commander must set up corresponding safety limits and range patterns.
The surface of a range should be level and if possible, soft enough to prevent or minimize ricocheting of the projectiles fired. The surface should be dug up either by plowing or harrowing for a distance of 50 ft in front of and behind all low angle strafe targets to insure maximum bullet absorption. This should be done at frequent intervals to insure that the surface does not harden.

Control Tower

The range control tower should be at least 30 ft high and located for ease of observation of targets and pattern. The distance from the targets will vary with the terrain. A control panel should be at the base of the control tower, in such a position as to be easily visible to the pilot turning in on his firing pass. This panel should be at least 10 by 10 ft and constructed so as to be easily changed from red to white. The position of this panel opens and closes the range. A red panel indicates a closed range, a white panel, an open range. This panel, in addition to radio and flare gun, will prevent pilots from firing on a closed range.
Items of equipment necessary to conduct operations are located in the control tower. The minimum of equipment is as follows:

a. Two-way radio equipment.

b. Wide vision binoculars.

c. Flare gun.

Spotting Tower

The construction of the spotting tower can be similar to that of the control tower. There should be a telephone system between the control and spotting tower and a duplicate plotting method in the spotting tower.

Low Angle Strafing Range

A low angle strafing range has normally 6 to 8 targets placed as shown on figure 4-21.
Each target is 15 ft square. The 36-inch bull's-eye is placed 36 in. above the center of the target to take care of gravity drop if the aircraft is harmonized for shorter ranges. (The 2-mil pipper coincides with the 36-inch bull at 1500 ft range). The targets are mounted about 80° from the horizontal, and are located 1200 ft from and parallel to the foul line. The target structure should permit easy removal of the panels for scoring. After each sortie a new target should be used, or the old ones carefully patched. Merely marking the previous bullet holes is not sufficient to insure correct scoring. Colored ammunition will aid in scoring, as some ricochet holes are very similar to actual bullet holes. Due to the angle of penetration, a highly visible color such as red or green will stand out the best.

Skip Bombing Range

The skip bombing range is very similar in layout to the low angle strafing range. There are two main differences. Each target is 10 by 20 ft, and the foul line is located 750 ft from the targets. The layout is shown in figure 4-22.
The terrain within a radius of 2 mi must be cleared of any obstructions that might interfere with the lengthly low level approaches.
The targets may be constructed from used aerial targets sewed together. For visibility the targets should be painted a color in sharp contrast to the background.

Dive Bombing, High Angle Strafing and Rocketry Range

The dive bombing, high angle strafing, and rocketry range consists of a pyramidal target or other suitable aiming point, control tower, spotting tower, and scoring system. The pyramidal target is 8 by 8 by 8 ft and is placed at the center of 150-foot circle. The layout is shown at the bottom of the next page. The circle may be constructed of any material cheaply procured such as used automobile tires. The color of the circle outline and the pyramid should contrast with that of the surrounding terrain. The spotting stakes are placed at 15-foot intervals, with one line perpendicular to the

LOW ANGLE STRAFING RANGE

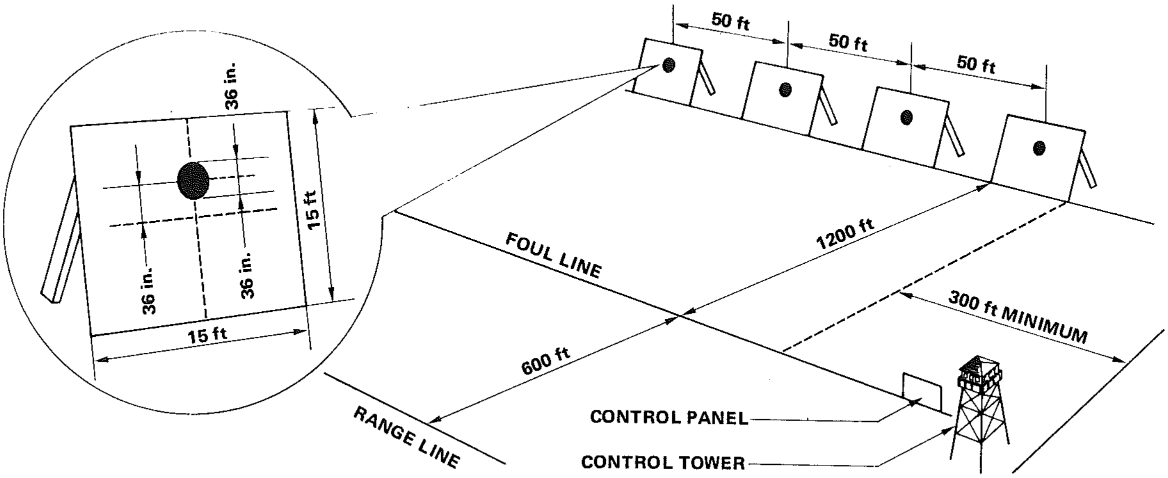


Figure 4-21.

SKIP BOMBING RANGE

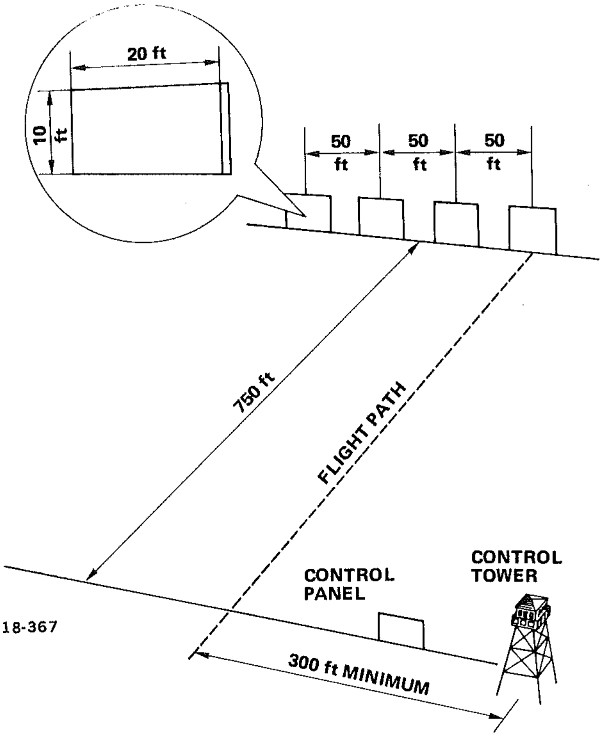


Figure 4-22.

control tower, and the other perpendicular to the spotting tower. An alidade can be used as an alternate method of plotting impact points.

One method for spotting is to place two lines of numbered stakes in front of the target as shown in the drawing of the range layout. One line of stakes is perpendicular to the line from the spotting tower to the center of the target. The other line of stakes is perpendicular to the line from the control tower to the target. Each line of numbered stakes is 150 ft from the target at the nearest point. Each stake should have a number in black 30-inch hight on a board 3 ft square. Distance between stake centers is 15 feet. The number of stakes is governed by local policy, but the minimum scoring circle should be 600 ft in diameter. In other words the "line" of numbered stakes should be of sufficient length to enable the plotters in the two towers to plot impact points for a radius of 300 ft around the bull's-eye. The arrangement of the stakes is shown in fig. 4-24. With the above arrangement, scoring can be done by observing the impact in relation to the nearest numbered stake. The stake numbers and approximate location of impacts are noted and sketched on a card and later plotted on a plotting sheet.

RANGE LAYOUT FOR DIVE BOMBING

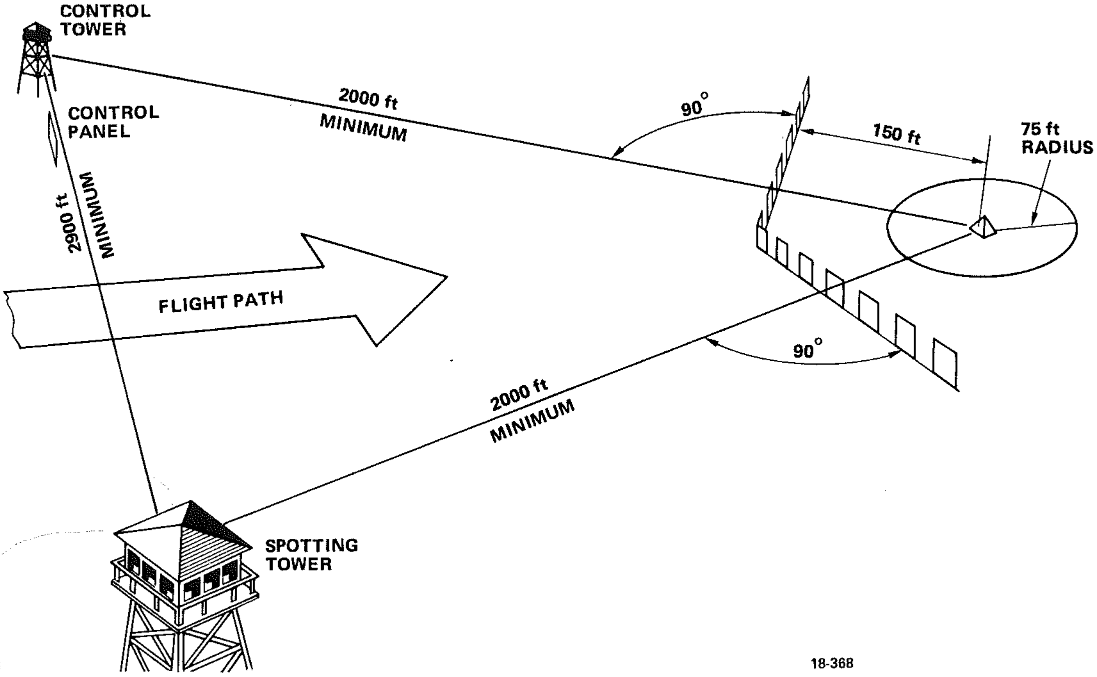


Figure 4-23.

ARRANGEMENT FOR SCORING STAKES

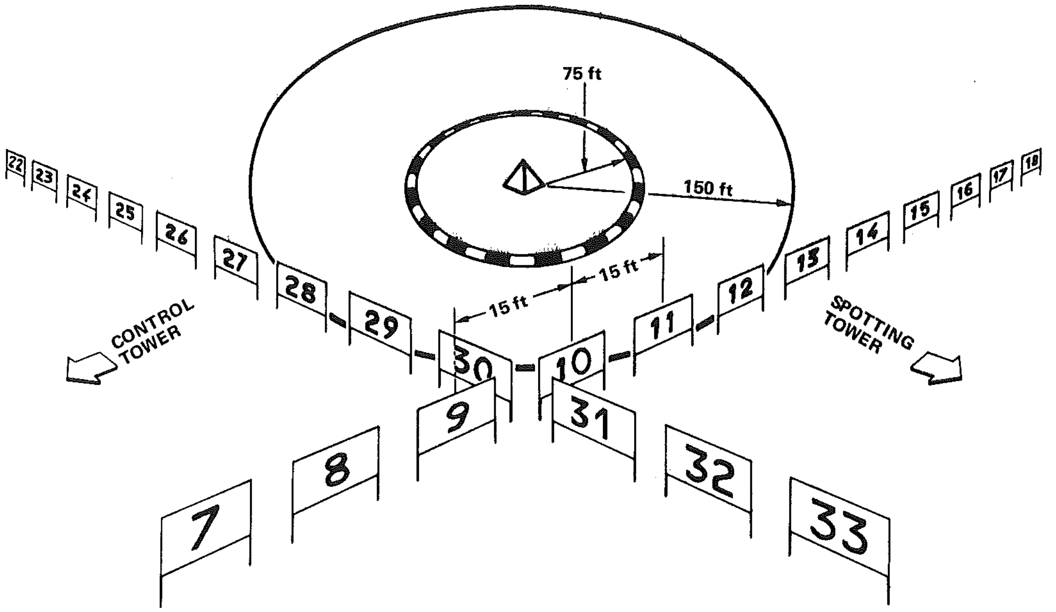


Figure 4-24.

Another method for spotting is by use of the simple alidade of the type shown on figure 4-25.

Consolidated Air-to-Ground Range

The three types of ground ranges may be easily consolidated. With the addition of another spotting tower and duplicate targets a dual range can be laid out as shown in figure 4-26.
The dual range is desirable, because it offers the possibility of right hand and left hand patterns, preventing a pilot from becoming a "left" or "right" pilot. Furthermore, one low angle strafing range may be scored while firing is being conducted on the other.
The recommended range line is 600 ft from and parallel to the foul line. The range line is the maximum distance from the targets where ordnances is discharged. This is to confine the skip bombing and low angle strafing ranges. However in some instances, at the discretion of the unit commander, the range line may be moved nearer to or farther from the foul line.

Range Procedures

All pilots will be thoroughly briefed on safety precautions and range procedures. Each flight will proceed to the range in accordance with local directives and establish radio contact with the ground range. Each pilot will then check in with the range officer giving his position in the flight, aircraft number, and name (or squadron number).
Upon reaching the range, each pilot will make a spacer pass at a minimum of 2000 ft above ground, to doublecheck the control panel, establish flight spacing, and enter the standard rectangular pattern. The pattern is shown in figure 4-27.
Each pilot will call his number and control panel color each time he commences the final turn on to his assigned target.
If a dual range is being used, the pilot will at this time also state the range. All patterns will be flown in such a manner to insure that the nose of the aircraft is never pointed at the control tower.
Dive bombing and rocketry patterns must be flown so that the flight path while firing is from the towers toward the target and perpendicular to a line between the control and spotting towers. Dive angles, slant ranges, and minimum altitudes will depend upon the type of missions flown. The illustration 4-30 shows a method for determining the aircraft's altitude above ground level during skip bombing.

SIMPLE ALIDADE

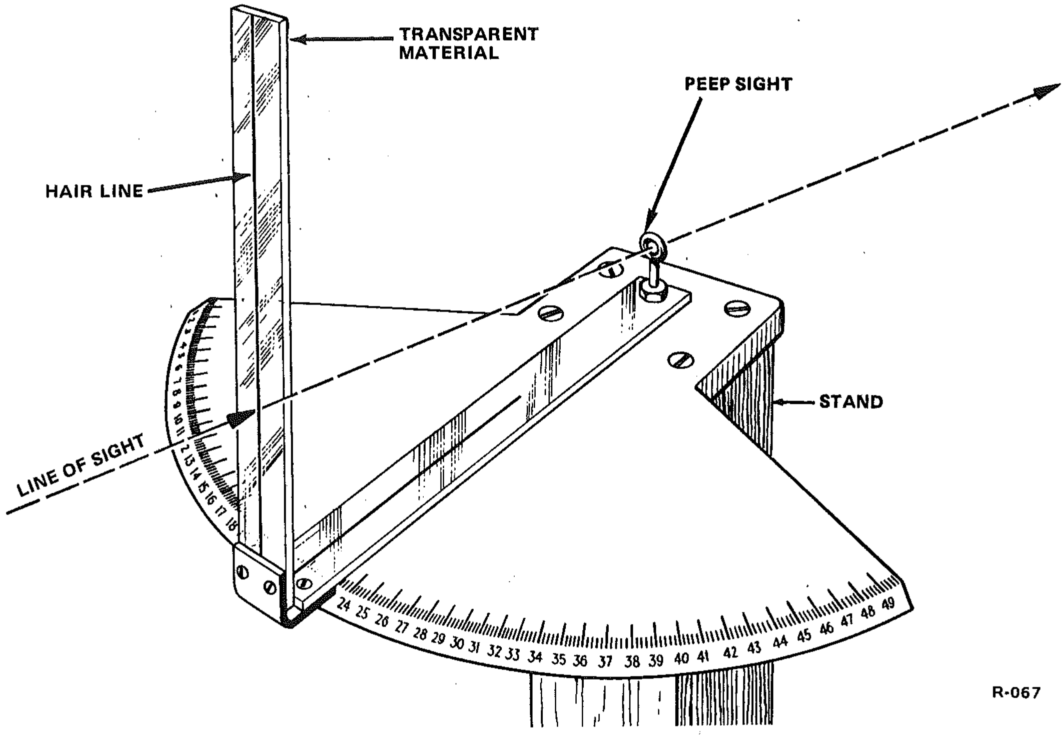


Figure 4-25.

CONSOLIDATED AIR TO GROUND RANGE

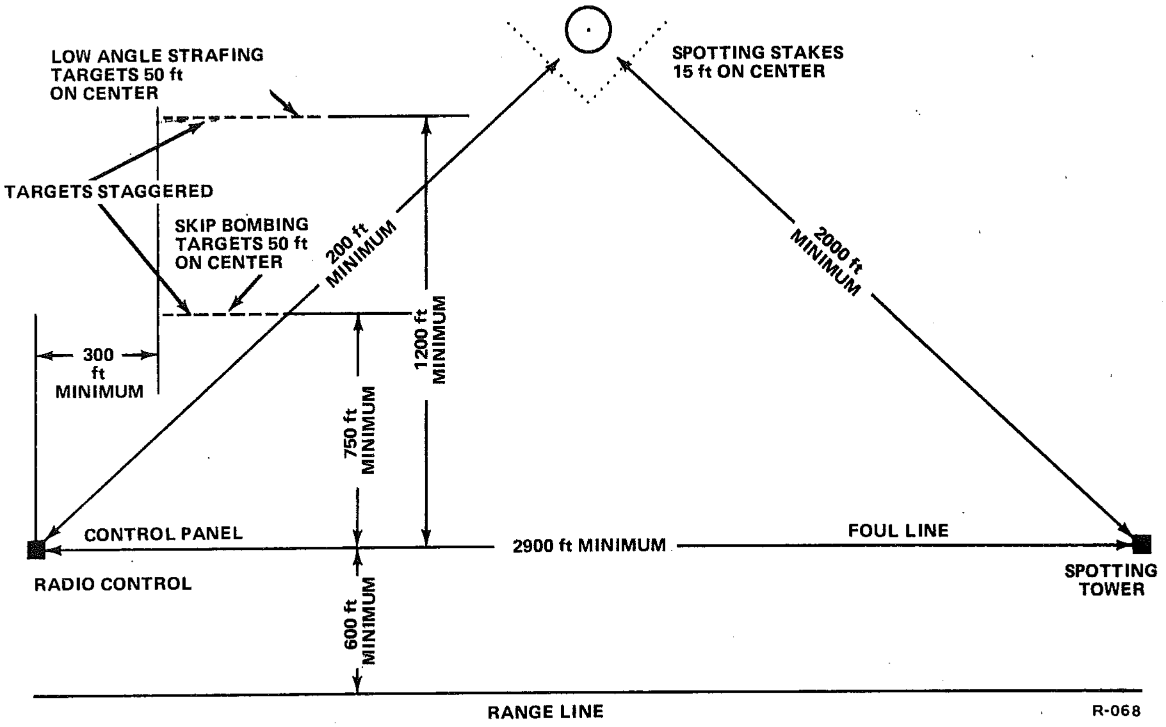


Figure 4-26.

FLIGHT PATTERN FOR LOW ANGLE STRAFING AND SKIP BOMBING

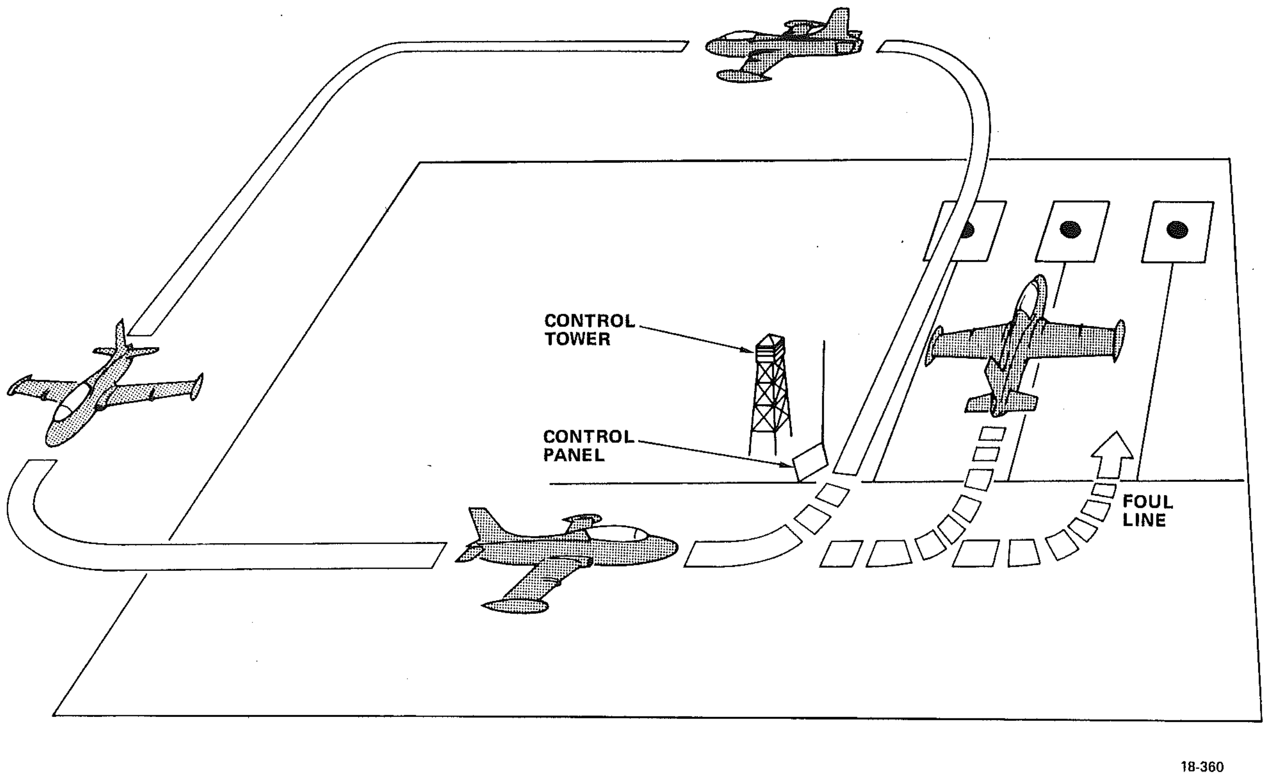


Figure 4-27.

Safety Precautions

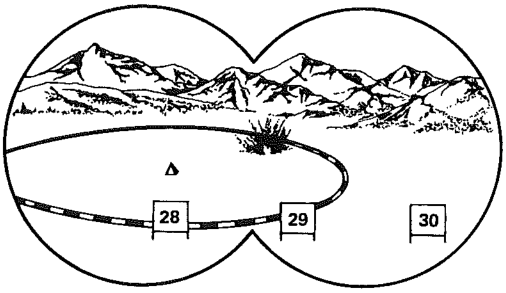
Safety measures will be observed in accordance with Local Air Force Regulations. The commander should issue timely warning through the local press and radio to prevent uninformed persons from trespessing on the range during periods that training is in progress.

After completion of firing, and prior to landing, pilots will turn off all armament switches, and comply with local safety regulations.

Under no circumstances will a pilot fire on a closed range or when he has negative radio contanct with all other members of his flight and the range.

Commanders will issue such local rules and regulations as are necessary to prohibit aircraft carrying live ammunition, practice or live bombs and rockets, from flying over cities, towns, or any areas where accidental firing or dropping might cause damage to government or private property or endanger life.

BOMB PLOT EXAMPLE



IMPACT POINT = 28¾

Figure 4-28.

NOTE

Bombing and rocketry range procedures and specification

MEMORANDUM - TRAINING WEAPON RELEASE

WRITE HERE THE RELEVANT DATA CONCERNING PRACTICE AIR-TO-GROUND AND AIR-TO-AIR MISSIONS WITH DIFFERENT TYPE OF WEAPONS									
AIR-TO-GROUND	EVENT	–							
	ARMAMENT	–							
	SIGHT SETTING	mils							
	BASE LEG ALTITUDE	ft							
	BASE LEG IAS	kt							
	BASE LEG POWER	%							
	DIVE ANGLE	deg							
	RELEASE PWR SET	%							
	RELEASE IAS	kt							
	RELEASE TAS	kt							
	RELEASE ALT AGL	ft							
	RELEASE SLANT RNG	ft							
	MINIM. RECOVERY ALT	ft							
	POWER TO CLIMB	%							
	DOWN WIND LEG IAS	kt							
AIR-TO-AIR	EVENT	–							
	ARMAMENT	–							
	TARGET ALTITUDE	ft							
	PERCH ALTITUDE	ft							
	PERCH POWER	%							
	PERCH IAS	kt							
	ENTRY POWER	%							
	ENTRY IAS	kt							
	REVERSE TURN IAS	kt							
	FIRING IAS	kt							
	FIRING TAS	kt							
	SIGHT SETTING	mils							
	CLIMB OFF IAS	kt							
	CLIMB OFF POWER	%							

Figure 4-29.

> in this manual are designed for the use of practice bombs and rockets. In the event other than practice bombs or rockets are used, appropriate range procedures and specifications will be adopted to maintain safety.

Unit commanders must be sure that all personnel operating the ranges or firing on them are thoroughly familiar will all range rules and procedures. It will be the responsability of the unit commander, usually through the range control officer, to see that all procedures and safety precautions are strictly enforced. The range officer should inspect the conditions of the range, especially the area around the low angle strafing and skip bombing targets, and insure that crash and fire equipment is standing by before opening the range for firing.

There will be a maximum of four aircraft in the air-to-ground pattern at any one time. The range officers will close the range if he is unable to establish radio contact with the flight. He will signify this by changing the control panel to red and/or firing red flares.

Scoring Methods

Low angle strafing and skip bombing scores are usually obtained as a percentage by dividing the number of hits by the total rounds fired or bombs dropped. Local policy determines reduction in score due to fouls or other violations during practice firing.

Dive bombing, rocketry, and high angle strafing plots are scored as footage error

METHOD OF DETERMINING ALTITUDE AGL SKIP BOMBING

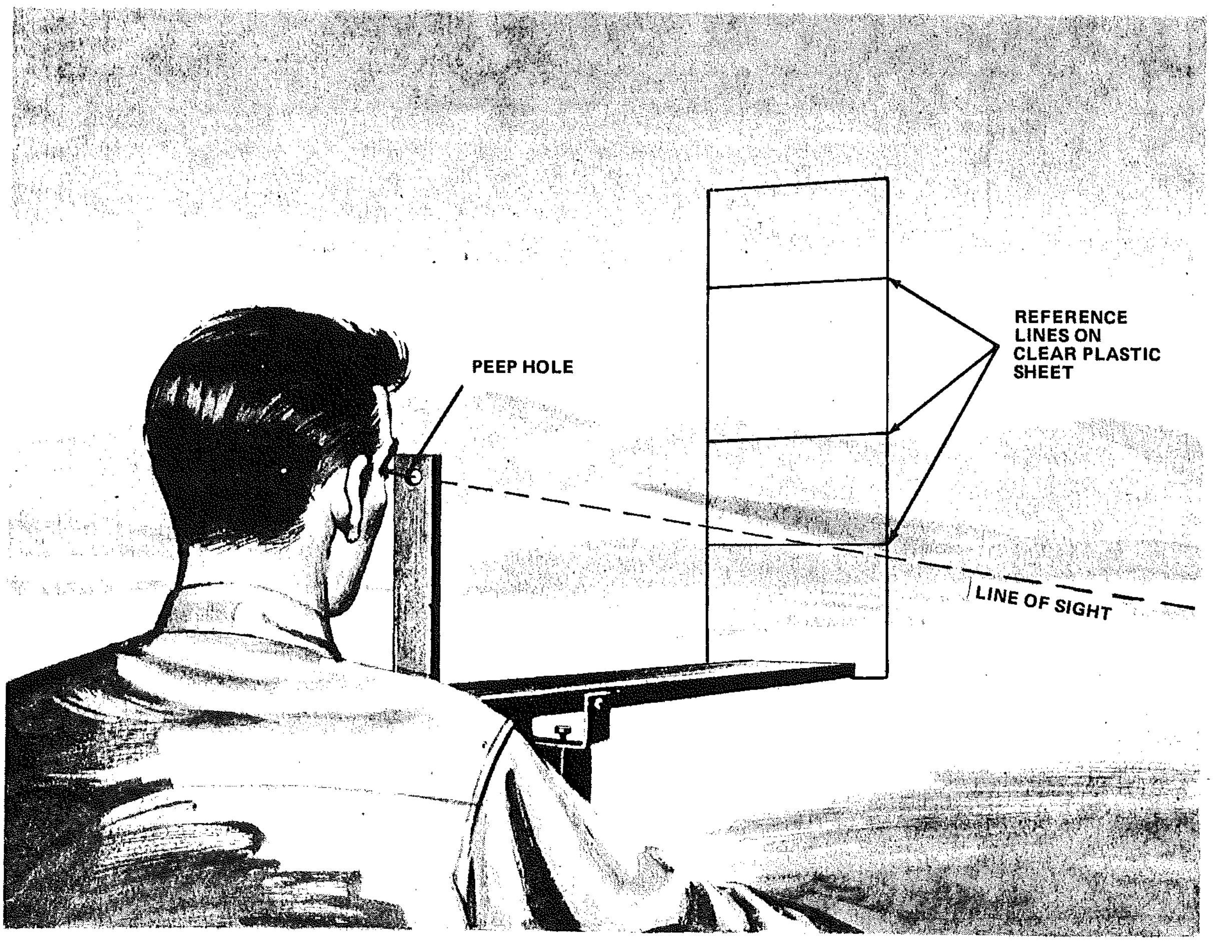

REFERENCE LINES ON CLEAR PLASTIC SHEET
PEEP HOLE
LINE OF SIGHT
R-069

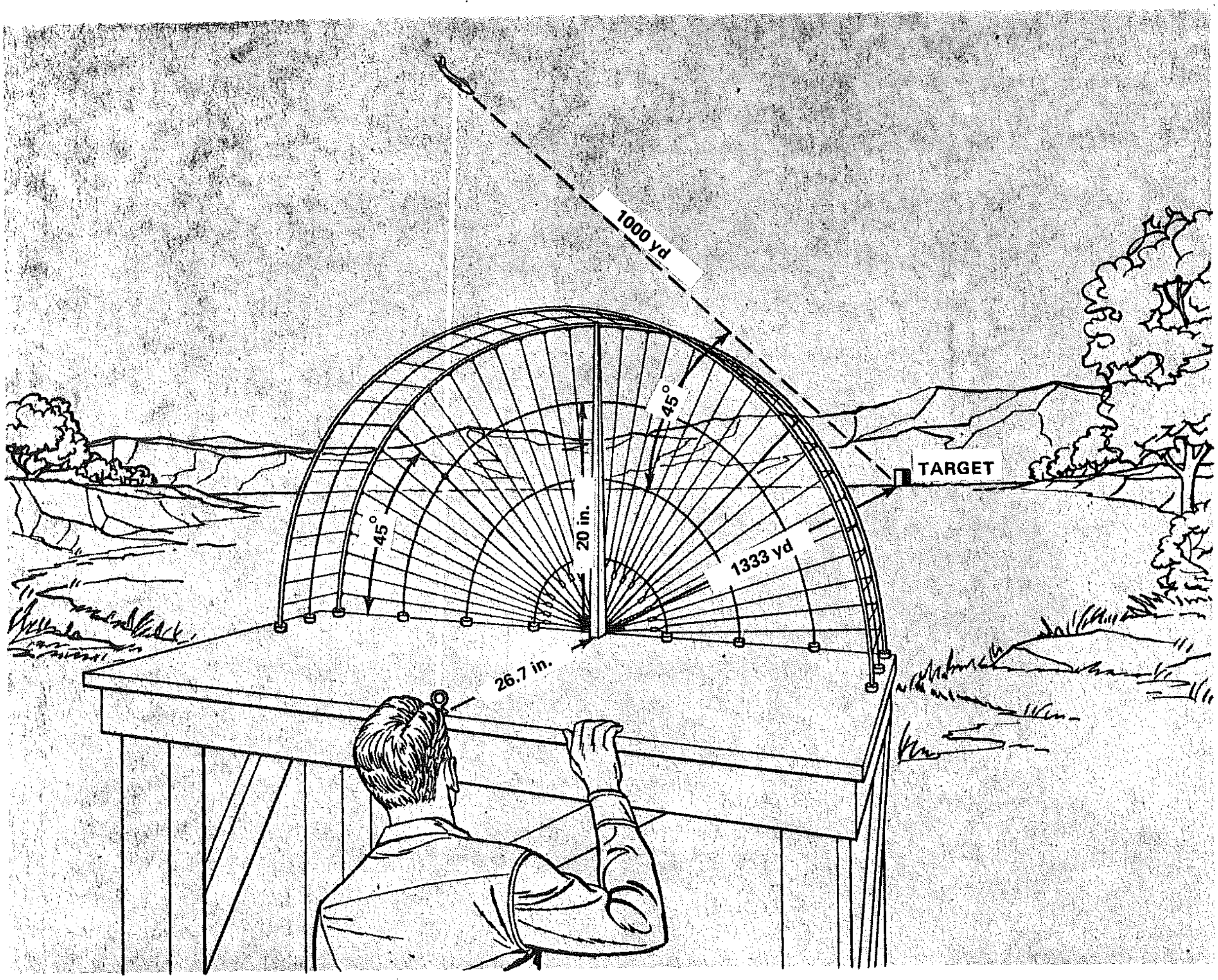
Figure 4-30.

from the bull's-eye. The number of the stake nearest the center of the impact is phoned to the control tower from the spotting tower. (The plots may be spotted to the nearest 1/4. In the situation illustrated in fig. 4-28, for example, where the impact points in three-fourths of the distance between stakes 28 and 29, the plot is 28 3/4). The impact point of the projectile is at the intersection of the line from the spotting tower to the stake and the similar line from the control tower. The footage error and cock position is determined from the score card and is called to the pilot to enable him to correct his next attack. The slant range and dive angle must be entered on the score sheet. The range and angle may be determined with a "harp" like the one shown on the figure 4-31.
Gun camera film should be utilized in conjunction with the above instrument. The film can be assessed to determine the slant range and dive angle.

Mission Scoring Records

All missions should be scored on applicable Mission Scoring Record Forms.

"HARP" FOR ESTIMATED SLANT RANGE AND DIVE ANGLE



By sighting through a peephole on the harp table the observer follows the motion of the aircraft, and notes along which wire the aircraft appears to be travelling. Each wire corresponds to some different dive angle; hence by radio communication the pilot is told what his dive angle is. Similarly, the harp is calibrated so that when the aircraft appears to cross one of the circular wire supports the range is known and can be radioed to the pilot.

Figure 4-31.

AIR-TO-AIR RANGE FLIGHT PROCEDURE

INTRODUCTION

The standard air-to-air pattern should be performed with a flight of four aircraft, each aircraft armed with two gun pods caliber .50 (or caliber 7.62 mm) installed on underwing station No. 3 and No. 4. If required, only one of the pods may be loaded.

Also when flying dry runs using the gun camera only, it is suggested to configurate the aircraft with two gun pods to accustom the pilot to maneuver in the same aircraft load and configuration as in a combat mission.

It is not advisable to perform air-to-air practice gunnery with the underwing tanks installed, though empty, or with any other pylon-suspended store. This is not determined by structural or controllability factors but only because the speed, maneuvrability and acceleration parameters will be altered with respect to the aircraft operational characteristic of the standard gunnery mission.

The power settings, airspeed and attitudes suggested for a standard air-to-air gunnery pattern and the procedure to perform coordinated attack against banner target A6B towed at 165 KIAS at 12 000 ft altitude are shown in figures 4-35, 4-36 and 4-37.

SIGHT CHECK

The fight leader will move the flight to an IN TRAIL formation as the flight is proceeding to the range area.

NOTE

It is suggested to change the personal, or Aircraft, radio call sign to an "operational" radio call sign as follows:

- All the formation: a short nick name, as "lion formation".
- The leader is therefore: "lion one" or "lion leader".
- The wingmen will be: "lion two", "lion three", "lion four".

If the towing aircraft is committed to a specific formation, the call sign will be, i.e. "lion target". (brief and easy names like lion, tiger, puma, fox, should be assigned to the various formations).

Assume positions 1500 to 2000 ft in trail of the plane in front of you.

Each pilot will perform the following check enroute to the air-to-air range:

a. Optical sight, Aeritalia 8-150-000 (Aircraft [B]); Air-to-Air live gunnery should be performed with this type of fixed sight taking particular caution to avoid to be led in the tail sector, extremely dangerous for the towing aircraft. The only sight check possible is for brillancy of the reticle and correct computed depression setting (always 8 mils).

b. Optical gyro sight, Thomson R322Z(M) (Aircraft [A]). Perform the general sight check as described in "prior to firing procedure". Section II. Be sure to have selected GAA on the sight selector switch.

c. Optical gyro sight, Thomson RD21 (Aircraft [B], [C] and [D]). Perform the general sight check as described in "prior to firing procedure". Section II. Be sure to have selected AA and D2.

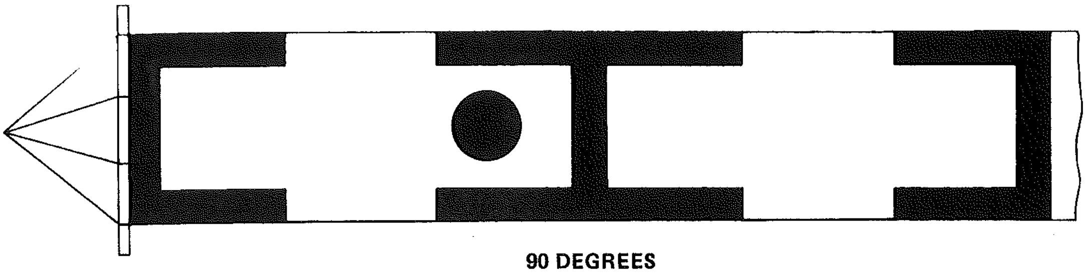
RENDEZ-VOUS WITH THE TOW AIRCRAFT

The flight will proceed to the range in the in-trail formation, climbing to an altitude of at least one thousand feet and not more than four thousand feet above the proposed tow altitude. The flight leader will contact the tow aircraft approximately one minute from the range so that a proper rendez-vous may be accomplished. After sighting the tow ship, and the time the tow ship is cleared to set course, the flight leader will position the flight for the spacing pass. As soon as the flight leader ascertains that the tow aircraft is setting course on the range, he will call for a radio channel change to the squadron frequency and ask for a radio check-in. The entire flight and the tow ship will check in.

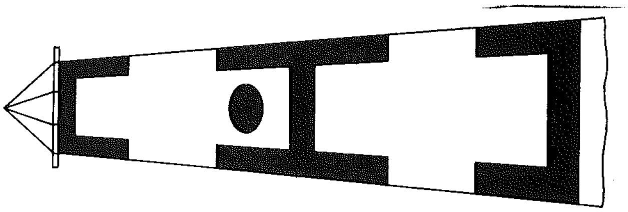
ENTERING THE AIR-TO-AIR PATTERN

The flight leader will position the flight so that a spacing pass may be made past the tow ship. This pass will be started from a position approximately 1000 to 4000 ft above the tow altitude and three to five miles to the rear. The primary purpose of this pass is to set up the pattern spacing, and the aircraft in the flight should be spaced at

A6B TARGET AT DIFFERENT ANGLES OFF

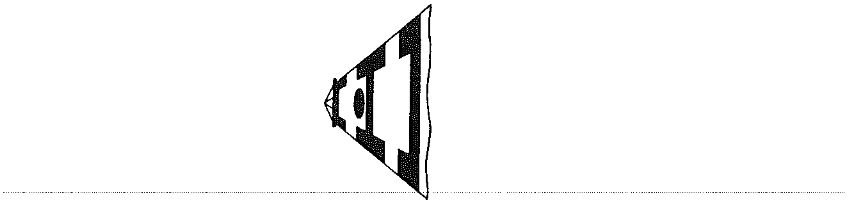


90 DEGREES



45 DEGREES

18-381



15 DEGREES

Figure 4-32.

least 1500 to 2000 ft in-trail. The flight leader will begin a shallow dive so that he will pass the tow ship on the proper side, at the tow ship's altitude.

PULL-UP FROM THE SPACER PASS

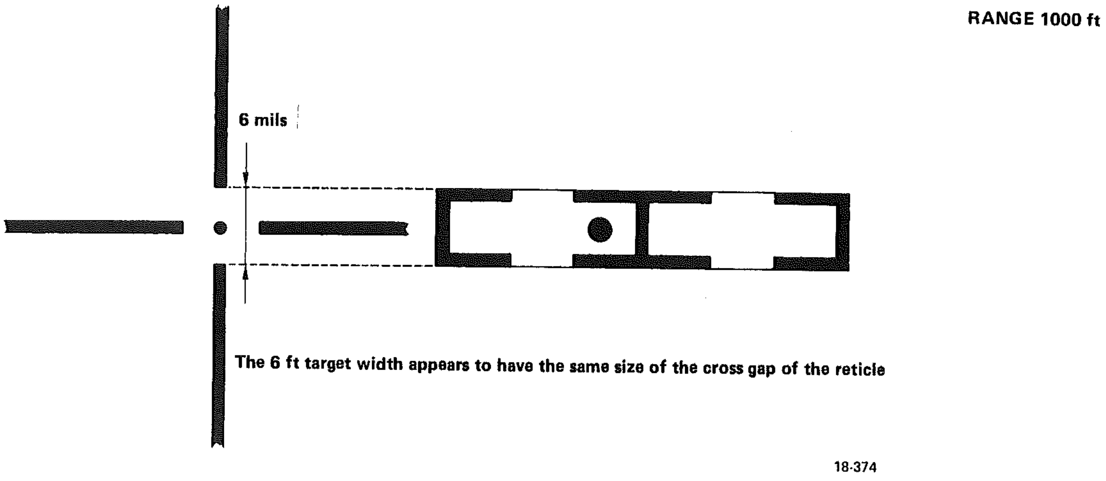
As you pass 100 to 200 ft to the side of the tow aircraft, and 1500 to 2000 ft behind the preceding aircraft, initiate your pull-up and make your call, i.e. "lion two off". The pull-up off the target to the perch position is accomplished by smooth coordinated flying of your aircraft, enabling you to gain your attack position by turning your airspeed advantage into altitude and position advantage.

To do this, establish a climb from 20 to 30 degrees before you roll into the turn toward the perch. Accomplish this initial part of the pull-up with your wings level as you pass the tow. The time involved should be used in orientating the position of other members of the flight. Now roll towards the direction of the perch, and having the position of the other flight members in mind, simultaneously look over your shoulder to regulate the amount of turn by your relationship to the tow aircraft. This climbing turn should continue until you are around to a position 65 degrees to 80 degrees from the flight path of the tow aircraft. This initial turn is dependent upon the type of aircraft and the altitude at which you are firing. At this point start a turn reversal still climbing, which will allow you now to see the aircraft preceding you in the pattern.

THE PERCH

By this time the aircraft preceding you will be on the perch, and relay to start his pass. As he is adjusting his position on the perch, you will see the aircraft opposite you in the pattern as he passes below you approaching to pursuit curve. Assuming that the aircraft preceding is in the proper position, you will fly your aircraft in such

A6B TARGET FROM AERITALIA SIGHT


RANGE 1000 ft
6 mils
The 6 ft target width appears to have the same size of the cross gap of the reticle
18-374

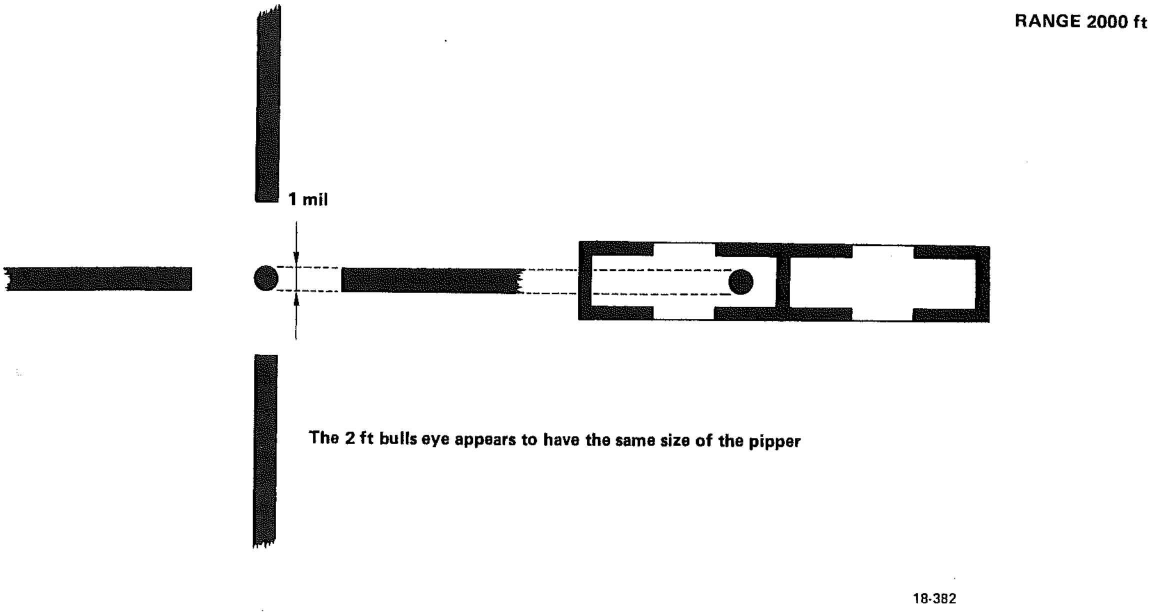
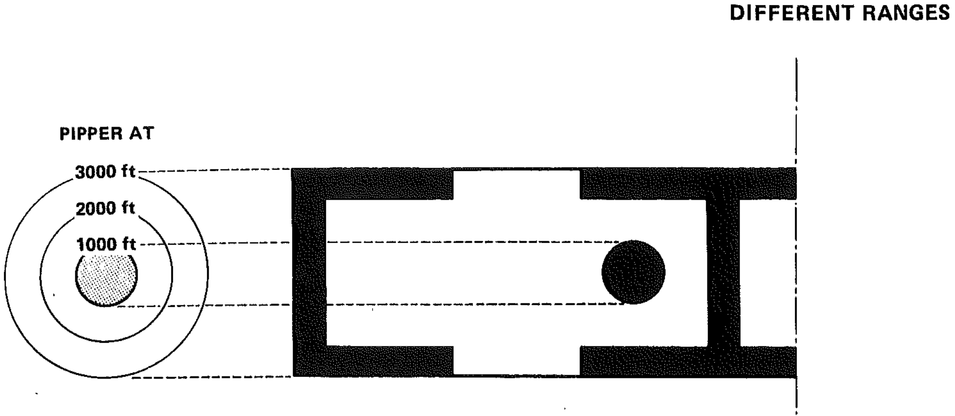

RANGE 2000 ft
1 mil
The 2 ft bulls eye appears to have the same size of the pipper
18-382

Figure 4-33.

a manner as to place your perch just in front of where he initiated his pass, assuring yourself that you have the proper altitude and airspeed. You may find it necessary at this point to climb above the perch altitude to insure proper clearance as the preceding aircraft flies under you on his turn in. As you roll out on the perch, adjust your position, altitude, and airspeed properly so that you are straight and level, and paralleling the two aircraft's flight path. As you are accomplishing this, you should have the position of all members of the flight orientated again, and at the proper time you may initiate your pass. There is always a possibility that the pilot preceding you in the pattern may be out of position on the perch. This is where it is doubly important that you fly the proper pattern yourself and not just follow the man in front of you. If he is too far ahead, your perch position will be behind where he started his pass. In the event that his position is behind where it should be, it may become necessary to lose sight of him while putting your perch in the proper relation-

A6B TARGET FROM THOMSON SIGHT [A], [B], [C], [D] AIRCRAFT



- At 1000 ft the pipper appears to have the same dimension of the bulls-eye.
- At 2000 ft the pipper appears to have a size which is two times the bulls-eye.
- At 3000 ft the pipper appears to be equal to the target width.

18-377

Figure 4-34.

ship to the target. This will be done only when you have assured yourself of a safe clearance and have received a call from him to the effect that he has you in sight. The same porcedure will be followed in the event that the pilot in front of you gets the pattern too wide. In holding your position in where it should be, only lose sight of him. When rolling into the perch, you may roll your aircraft all the way into an inverted attitude enabling you to keep sight of him as he turns in under you on his pass. As you approach the perch position always remember you are flying over or above the pilot turning off the perch into his pass.

THE ENTRY TURN

The optimum conditions would be to have every phase of each air-to-air gunnery pass identical; however, until you have fired a considerable amount of gunnery, this is almost impossible to be achieved; this fact makes it important that you know the procedures to follow when you find yourself on the perch, and not in the proper position for the pass. This does not mean that you cannot make a pass from this position, as it is possible to salvage the pass by varying your entry turn to allow you to reach the turn reversal (key point) at the same relative position each time. Assuming that you are in the proper perch position you will initiate the turn in by starting a diving turn towards the target. The majority of your altitude advantage will be used in this turn to increase your airspeed to within 20 or 30 kt of the firing speed for the particular type of aircraft you are flying. This diving turn should be completed with the target still just below the horizon, and in the center of the windscreen of your aircraft. At this time you will begin adjusting the piper to its proper position and begin tracking the target. This point in the pattern is referred to as the reversal or key point.

If your perch was out of position at the start of your turn in, it will be necessary to make adjustements in your rate of turn to allow you to arrive at the Reversal at the proper range and angle off. If you are ahead or close in, you must increase your rate of turn. If you are behind or wide, you must make a slower rate or turn.

Failure to correct for errors in pattern positioning on your turn in, will cause you to be out be position at the reversal point.

THE REVERSAL (KEY POINT)

Regardless of the type aircraft or the altitude of the mission you are flying, the reversal is considered to be a key point, and unless it is set in the proper position your pass may become ineffective. At this point you should be 75 to 90 degrees from the target's line of flight 3000 to 4000 ft away from the target, 20 to 30 kt below firing speed, and 1000 to 1500 ft above the target altitude. From this approximate position you can see that the greater the angle off, the further you should be from the target, and conversely the closer you are, the less the

AIR-TO-AIR GUNNERY PATTERN

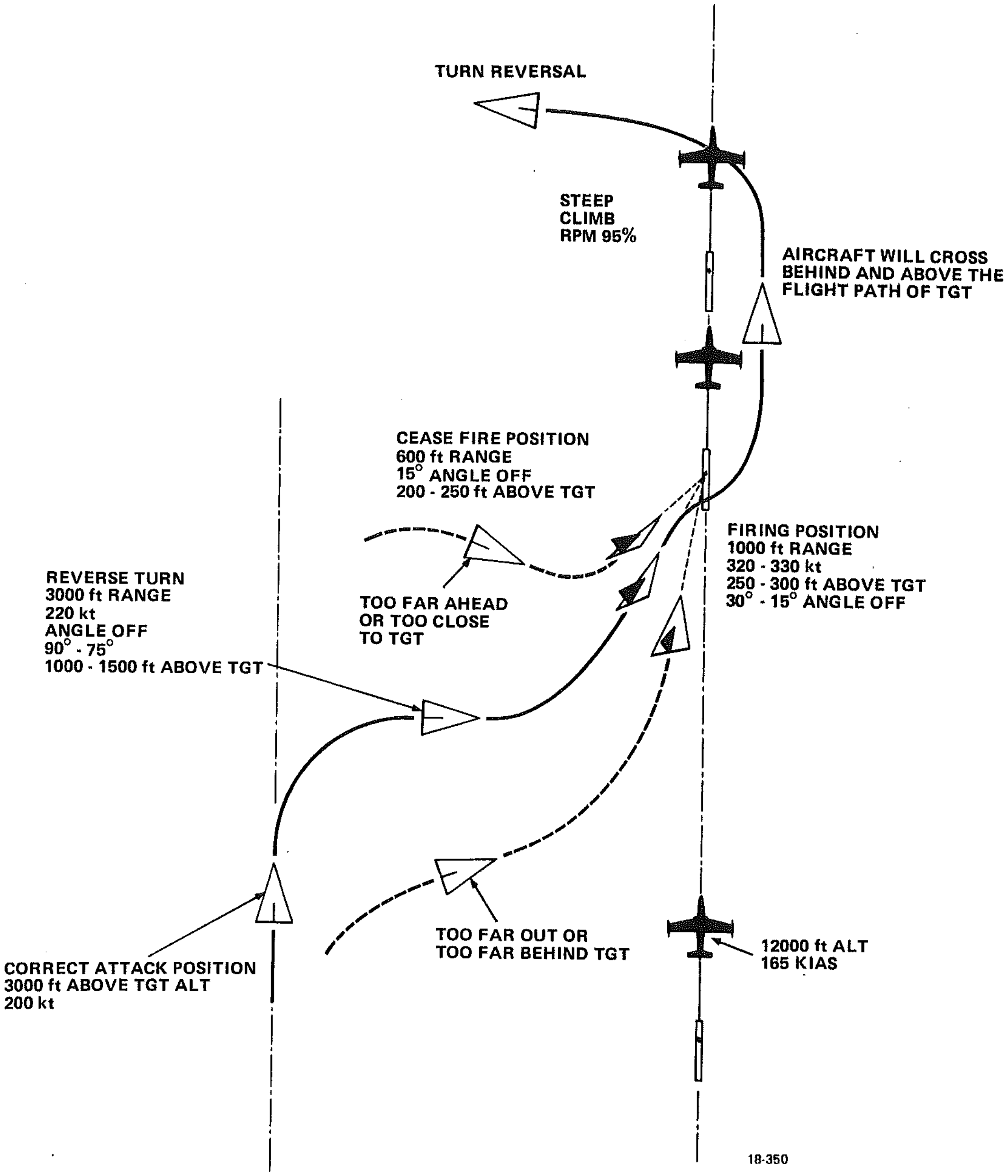

TURN REVERSAL
STEEP CLIMB RPM 95%
AIRCRAFT WILL CROSS BEHIND AND ABOVE THE FLIGHT PATH OF TGT
CEASE FIRE POSITION 600 ft RANGE 15° ANGLE OFF 200 - 250 ft ABOVE TGT
FIRING POSITION 1000 ft RANGE 320 - 330 kt 250 - 300 ft ABOVE TGT 30° - 15° ANGLE OFF
REVERSE TURN 3000 ft RANGE 220 kt ANGLE OFF 90° - 75° 1000 - 1500 ft ABOVE TGT
TOO FAR AHEAD OR TOO CLOSE TO TGT
TOO FAR OUT OR TOO FAR BEHIND TGT
12000 ft ALT 165 KIAS
CORRECT ATTACK POSITION 3000 ft ABOVE TGT ALT 200 kt
18-350

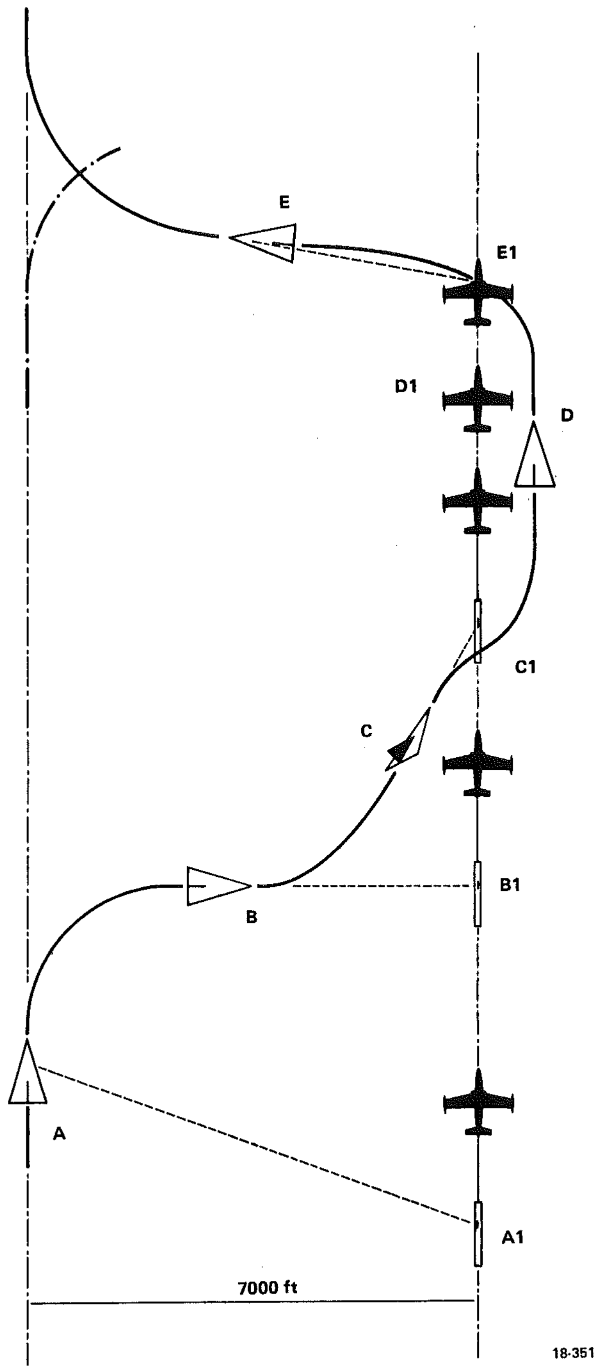
Figure 4-35.

angle off should be.
The type aircraft, its turning radius, and the altitude at which you are firing are the prime factors in determining the conditions you will choose as optimum for the reversal point.

THE PURSUIT CURVE

The goal you have been striving for thus far in the air-to-air pattern is to place your aircraft into a pursuit curve enabling you to bring your guns to bear on the tar-

FIGHTER TO TARGET RELATIVE POSITION



A. FIGHTER 3000 ft ABOVE TARGET - 7000 ft APART - ANGLE OFF 100/110 DEG.
B. FIGHTER 1500 ft ABOVE TARGET - 3000 ft APART - ANGLE OFF 90/75 DEG.
C. FIGHTER 300 ft ABOVE TARGET - 1200/1000 ft RANGE - ANGLE OFF 30/15 DEG.
D. FIGHTER SAME LEVEL OF TARGET - 100 ft LATERALLY.
E. FIGHTER 2000 ft ABOVE TARGET - 3000 ft APART - ANGLE OFF 80 DEG.

Figure 4-36.

get at a safe angle off, and in effective firing range. This pursuit curve will be a cone from 15 to 45 degrees of angle off, 0 to 5 degrees above the target's flight path, and from 1200 to 600 ft firing range.

NOTE

Do not fire up at a target.

The pursuit curve on your first pass should be used primarily to recheck and adjust the trim. Although you have trimmed the aircraft straight and level on the spacer pass, you may find that some aircraft will require just a little rudder trim to keep the ball in the center during this phase of the pass.

Smooth tracking in the pursuit curve, is generally considered to be the most important factor in effective air-to-air gunnery and rightfully so, however, to be 100 percent affective on every pass a combination of several techniques must be adhered to. You must know your sight, understand and be able to fly the air-to-air pattern, achieve the proper positions and airspeed, and most important, you must be coordinated. One of the most common errors at this point is the inadvertent use of rudders. You will find that little or no rudder pressure is required if you have the aircraft properly trimmed.

The most effective means of acquaiting yourself with what the target looks like at different angles off is your film assessing. Know especially what it looks like at 15 degrees: at this angle it will appear almost square. At lower angles, you will no longer be able to distinguish the bull's-eye, and the target will appear higher than it is long. See figure 4-32. You will see this when you have allowed yourself to fall into what is called a "Tail Chase". DO NOT pursue the attack under these conditions; break it off and position yourself properly on the next pass. If you fire at a lower angle than 15 degrees you not only endanger yourself, but he tow aircraft as well. In assessing your target you can judge the angle at which you fired by the length of the holes. If more than five sets of three strands are cut in an A6B polythelene target, the projectile was fired from less than 15 degrees. Range estimation is judged primarily by comparing the reticle of your sight to the six foot width of the target or the bull-eye on the target. You know that one mil subtends a width of one unit at 1,000 units. This comparison is much more accurate than estimating range just by looking at the target without a means of cross checking your own judgement. Another cross check is by counting in your mind, the length of time it takes you to pass behind the target after you stop firing. This method is more valid for pegged range firing and does not tell you when to open fire, but merely gives you a rough idea, after the pass, as to whether you were out of range or not.

For example, let us assume that you are firing on a target 12 000 ft. Your firing speed is 320 KIAS, or 198 KTAS (334 ft/s), depending on your angle off, your closing speed is roughly 320 ft/s, therefore if, after you stop firing, it takes you two seconds to pass the target you can assume that your cease fire range was approximately = 640 ft. From this information you can see that it should take one to two seconds to pass the target after you cease fire, if you are coming into the proper range.

BREAK-OFF AND PULL-UP

The best means of picturing in your mind the break-off maneuver is to use your hands. Make one hand the target, and put the other hand in a simulated pursuit curve position. Now you can see that it would be possible to continue your pursuit curve and collide with the target; therefore, as you cease fire you must do a combination of two things simultaneously. Relax your back pressure, which if done alone, would allow you to miss the target by merely sliding behind it. This is not effective if you are at a low angle off. You must also bring your wings level at the same time. This maneuver is similar to what you would do in abruptly rolling out of a tight break in air-to-air tactics. This will prevent you from colliding with the target in the event you have fired in too close, or if the target has been shot off.

The break off will carry you to the opposite side of the target, and you should level your wings, fly up opposite the tow aircraft, and as you pull-up you will make the required call, i.e. "lion four, off".

SPACING IN THE PATTERN

Your first thought may be, since you probably have fired with only two or sometimes three aircraft in the air-to-air pattern, that four is too many. Notice in the fig. 4-37 how simple, and more effective it is to fly with four aircraft. You can see that the numbers one and three are always opposite each other, and the same with two and four. You not only have ample separation for safety, but it will also aid you in good

FIGHTER POSITION IN THE RANGE

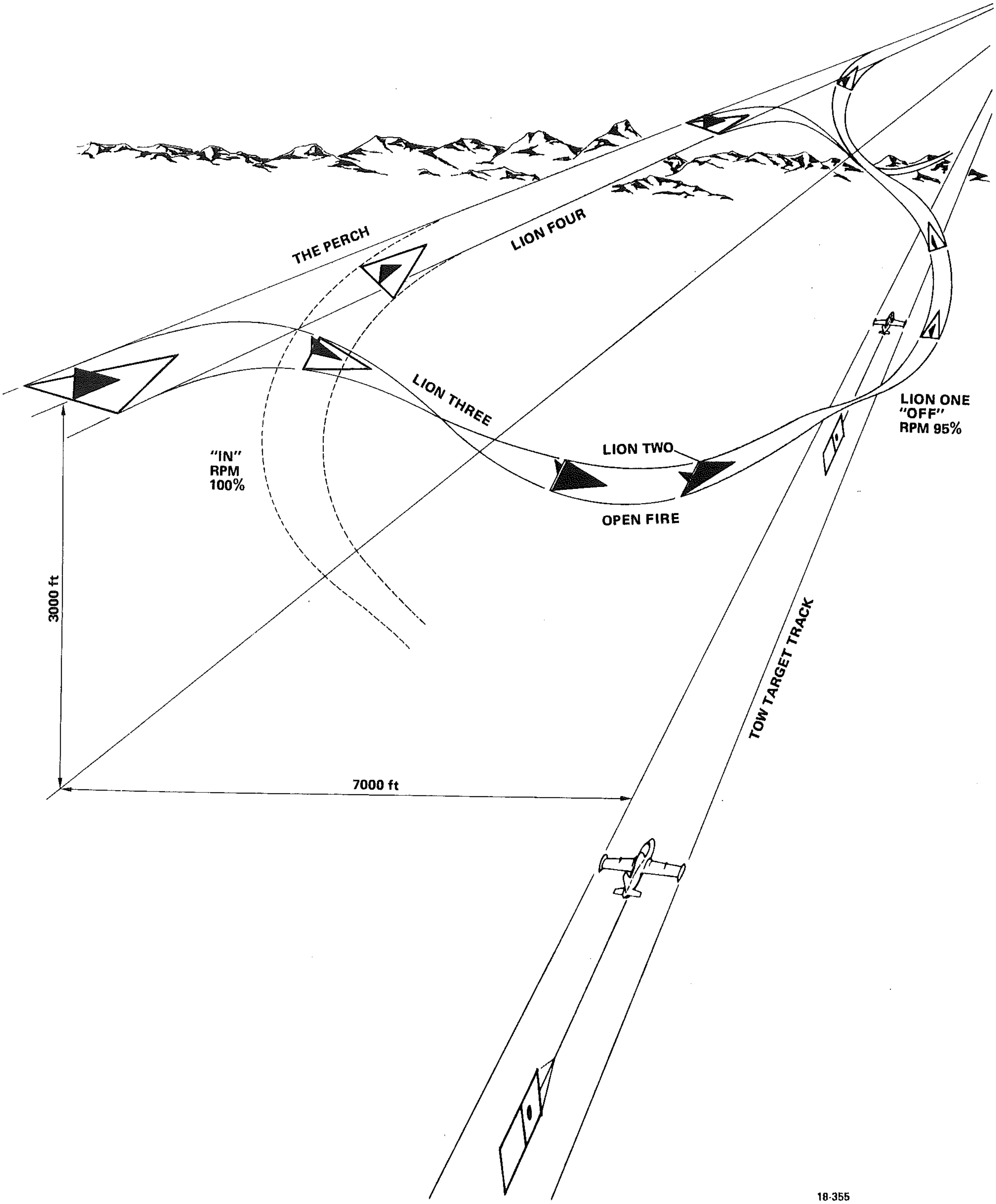


Figure 4-37.

timing, and keeping track of the tow aircraft. If, as you are ready to turn in off the perch, you find that you have momentarily lost sight of the target, you can easily pick him up by looking ahead of the aircraft preceding you in the pattern.

WARNING

- To avoid the danger of a mid-air collision, to keep out of the firing range of the following in formation aircraft when it is shooting to the target as well as to avoid the danger of hitting the towing aircraft it is necessary to follow scrupolously the undercited precautions:
- The "number three" aircraft will not start the "in" manoeuver till the "number one" declares the "off" (The same procedure will be followed by the "number two" with respect to the "number four").
- The aircraft which opens fire must be slightly higher than the banner (approximately 300 ft) NEVER BE LOWER.
- The pull-up toward the perch must be started with e steep climb, then the attitude will be eased in the final approach to the "perch".
- Along all the pattern each aircraft must keep well in sight the other three aircraft of the formation as well as the target.

RETURN FROM THE AIR-TO-AIR RANGE

After the flight leader completes his last pass on the target, he will call, "lion leader off", and climb to the "two o'clock" (or "ten o'clock") position for join up".
The flight leader will also make a call that the armament switches are off.
As each member of the flight completes his last pass on the target, he will call "off". Prior to joining up with the flight, he will check his sight and gun switches "off", as indicated above, and he will make the mandatory call; i.e. "lion two switches off". The flight will join up in close formation.

TARGET SCORING

The score is computed on holes in the target against rounds fired.
Film assessing is by no means the only accurate method of assessing your mission. You should assess every target for the grouping and length of holes. The grouping of holes will tell you whether you are overleading or underleading. This could be caused by incorrect tracing, too high or too low an airspeed, or possible sight trouble. The groupings will also show if you are shooting high or low. This may be caused by incorrect tracing, inadvertent use of rudder, or possible sight trouble. The length or holes indicates the angle off at which you are firing. In pegged range i your passses are constantly the same, a cross check of the groupings and length of holes will tell you range and angle off. Now compare your target assessing with your film, and you will have the information necessary to continually improve your proficiency.

AIR-TO-AIR PRACTICE GUNNERY WITH AERITALIA FIXED GUNSIGHT

To conduct with safety an air-to-air attack using a fixed type gunsight it is necessary:

1. To open fire from an altitude higher than that of the banner target, to avoid the risk to hit the towing aircraft.
2. To cease fire with an "angle off" still higher than 15 degreees.

To have a good chance to hit, it is required:

1. To perform a pursuit curve at constant "g".
2. To compute exactly the fire data and to fly the pattern following the computed parameters.

Because the Aeritalia sight has not the possiblity to change the dimension of the reticle circle, it is not possible when using this sight, to introduce the lead angle values by setting the circle radius to a value equal, in mils, to the lead angle.
It is not possible also to introduce in the sight the lead angle acting on the reticle depression values, because the aircraft is led to the attack with a bank angle which is not 90° (60° with "2 g"), therefore bringing the reticle in depression will provide

the results depicted by means of dotted lines, on figure 4-38.
Consequently it is necessary to estimate the lead angle, precedently computed and take into consideration also the little correction due to the gravity drop as shown below.
If the lead angle would be introduced in the sight using the depression button, the reticle would be displaced as shown in the dotted position of figure 4-38 and the relevant position of the banner target will be positioned where it is designed.
It would be very difficult to align the target vertically above the pipper by a height equal to the lead angle multiplied by the cosine of the fighter inclination angle. Therefore we do not advise to use this method, but to align the pipper with the EGBL (effective gun bore line) corrected for the velocity jump error.
The firing data of the MB-326K( ) aircraft have been accurately computed in the following flight conditions:

- Pursuit curve "ISOGEE" at constant 2 g (wing bank 60°), turn radius 7750 ft.
- Target altitude 12 000 ft, temperature ISA + 15°C (30°C at ground level and + 6°C at 12 000 ft).
- Target speed 165 KIAS = 200 KTAS = 337 ft/s.
- Fighter speed 320 KIAS = 385 KTAS = 650 ft/s.
- Open fire at 1200 ft slant range and 300 ft above target altitude.
- Cease fire at 800 ft slant range.
- Aircraft mass at the moment of fire: 8000 lb; load factor 2 g.

In this conditions of flight take note of the following parameters:

- Dive angle at firing range 14°28'.
- Angle off at open fire 28°45'.
- Angle off at cease fire 21°05'.
- Time to fire: 1.22 s.
- Parallax correction 3 mils.
- Velocity jump angle at 320 KIAS = 4.87 mils (this parameter can be corrected by means of the sight depression) therefore:

Depression to be introduced (always the same) for air-to-air practice gunnery = 4.87 + 3 = 8 mils

- Gravity drop for ammunition .50 cal at 1200 ft = 27 in. (1.9 mils).
- Gravity drop for ammunition 0.50 cal at 800 ft = 12 in. (1.3 mils).

This parameter can be corrected only by horizontally aligning the pipper with the white space located between the bulls-eye and the upper black edge of the target.

Lead angle at 1200 ft = 50.9 mils.

Lead angle at 800 ft = 36.4 mils. It must be evaluated by sighting the target in relation to the reticle circle.
Such a circle has a 50 mils radius, therefore the target, at the moment to open fire and to cease fire will appear like the following figure 4-38.

NOTE

During air-to-air missions the firing will be carried out with the aircraft under g loads. To obtain the zero sight line angle of attack from table it is necessary to enter the diagram, not with the IAS, but with the virtual lifting airspeed which is:

$$Ve = \frac{IAS}{\sqrt{n}}$$

1. Lead angle, mils = $\frac{V_t}{V_p}$ x sin angle off x x 1000

V_t = Target Speed; V_p = Projectile Speed

2. Turning radius (isogee)

$$R = \frac{V_f2}{\sqrt{(n^2 - 1) X g}}$$

Assuming V_f = Fighter Speed = 650 ft/s and n = 2 (2 g steady turn).

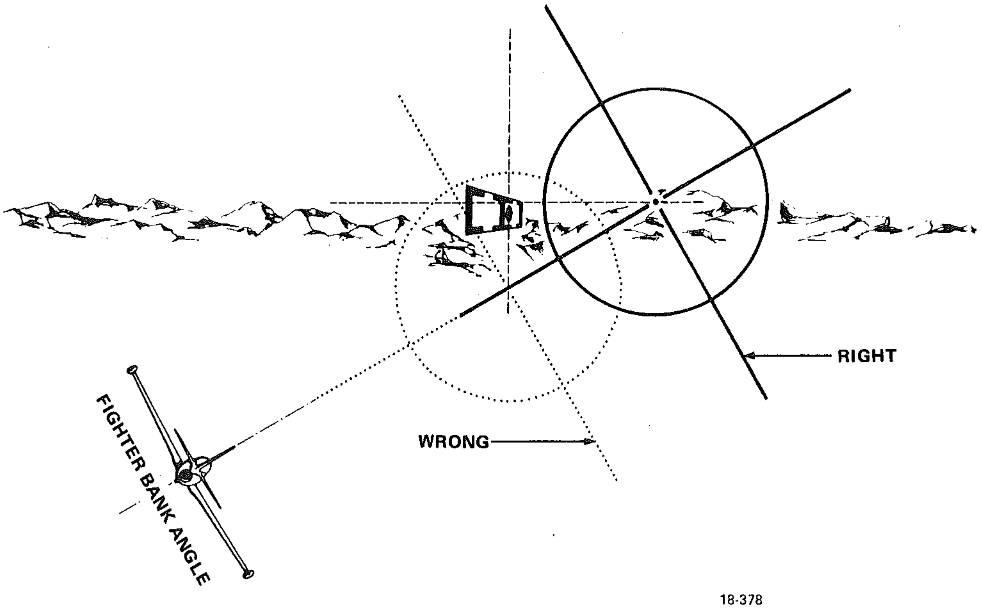
$$R = \frac{V_f2}{\sqrt{(n^2 - 1) X g}} = \frac{650^2}{\sqrt{(4 - 1) X g}} =$$

$$= \frac{422500}{\sqrt{3 X 32.25}} = 7574 \text{ ft}$$

AMMUNITION PAINTING

Bullets can be painted so that they will make colored holes in targets. The paint ma-

AERITALIA SIGHT IN AIR-TO-AIR GUNNERY [A] AIRCRAFT



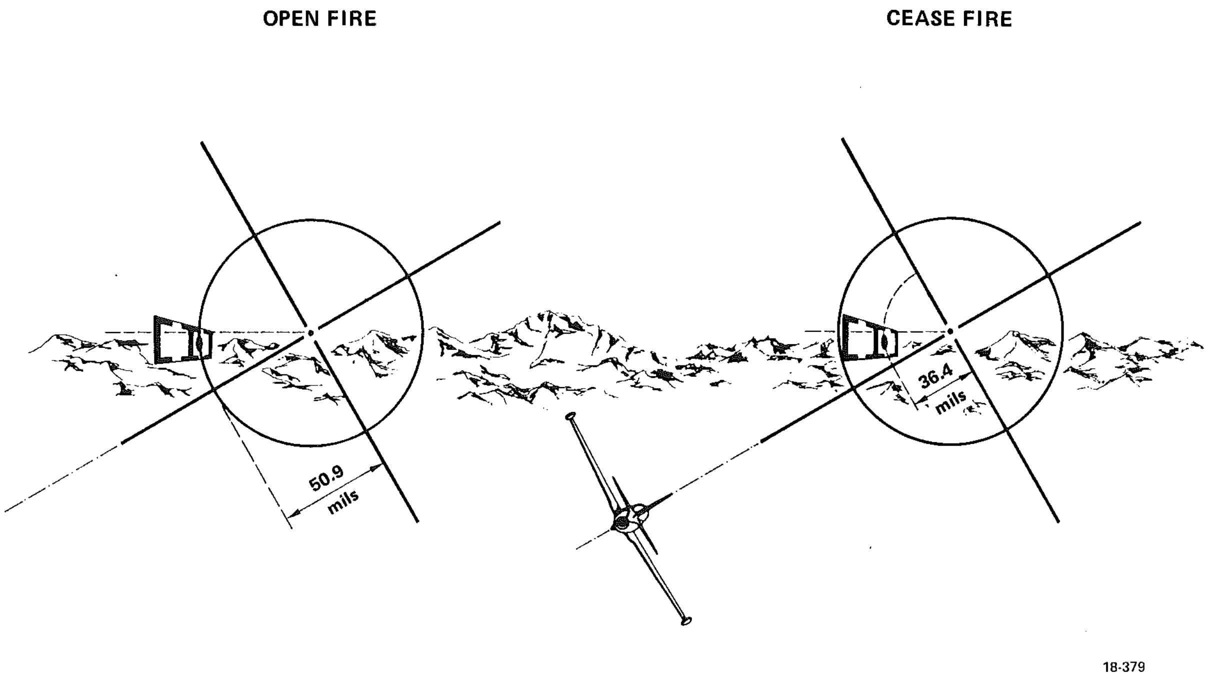


Figure 4-38.

PURSUIT CURVE - ISOGEE

RELATIVE POSITION	SLANT RANGE FT	ANGLE OFF DEG	MEAN Vp FT/SEC	$\frac{Vt}{Vp}$ X 1000	SIN ALPHA	LEAD ANGLE MILS
1	1300	30°00'	3.129	107	0.500	53.5
2	1215	28°45'	3.160	106	0.481	50.9
3	1130	27°25'	3.195	105	0.460	48.3
4	1046	26°00'	3.230	104	0.438	45.5
5	963	24°30'	3.265	103	0.414	42.6
6	881	22°55'	3.300	102	0.389	39.6
7	800	21°05'	3.333	101	0.360	36.4
8	720	19°20'	3.370	100	0.331	33.1

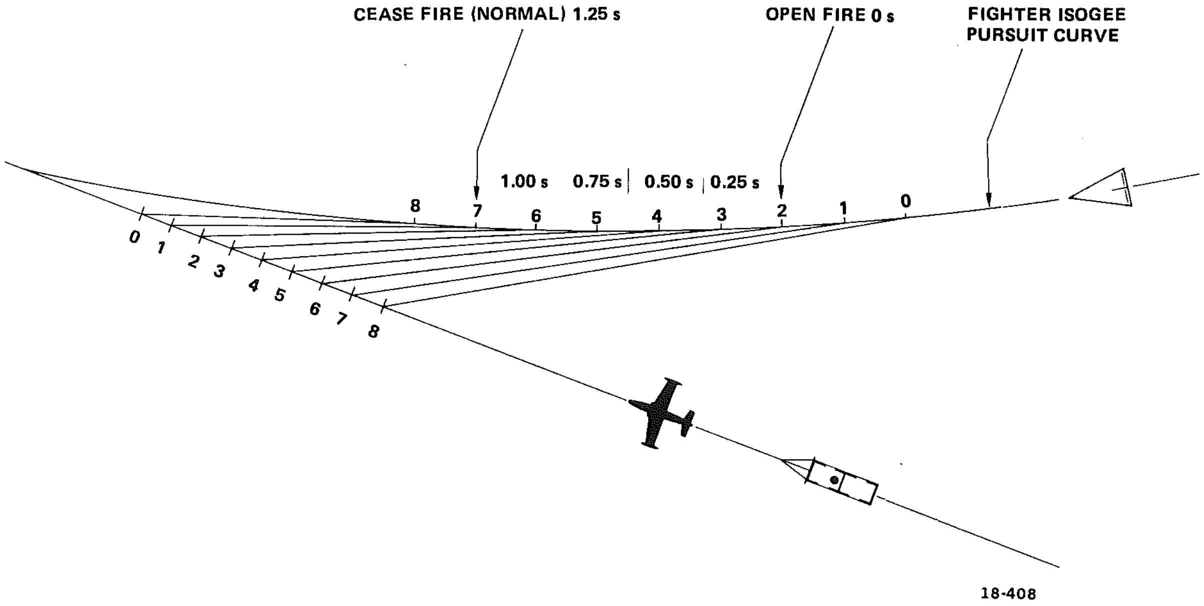


Figure 4-39.

kes the holes easier to find. The holes in an aerial target are readily identified regardless of angle-off. If the target is scored against a white background the colors stand out clearly.

A separate color can be used by each pilot firing on a target. The individual scores can be determined by means of the colors.

Mixing the Paint

The biggest problem is to develop a paint hard enough to withstand handling, yet soft enough to mark clearly when passing thorugh a target. A good method is to mix beeswax with bullet tipping paint (standard issue). The amounts of beeswax are as followed: 4 ounces for each gallon of black paint, 7 ounces to each gallon of purple, and 6 ounces to each gallon of red, green, orange, yellow or blue.

The beeswax and the paint should be heated to the same temperature in a thermostatically controlled melting pot. When pouring the wax into the paint, stir constantly. After the mixture has cooled, add paint thinner until desired consistency is obtained.

The wax melting pot mentioned above may be requisitioned through normal supply channels

Dipping the Ammunition

Assemble the ammunition in belts of convenient lengths (90 or 100 rounds) and make a tight coil of each belt. Pour the paint mixture into a shallow pan. Aline the bullets by placing a coil (projectile end down) on a flat surface and tapping gently. Dip the projectile end of the coiled ammo into the pan of coloring paint. Be sure the paint is applied only to the tapered portion of the projectile. Place the coil of ammo, still projectile end down, on a drain surface to allow the excess paint to drain off. The fiberboard squares which come packed in ammo boxes make good drainboards. Allow the painted ammo to dry for 6 h before using. If the painted ammo is not required for immediate use. It can be repacked in the boxes with little damage to the painted tips. The painted ammunition should be stored in a dry warm place away from munitions, etc. It should never be exposed to the sun for long periods of time.

Painted ammunition should be used in a reasonable length of time, otherwise its marking qualities will be greatly reduced.

Substitute for Bullet Tipping Paint

Litograph ink may be used instead of bullet tipping paint. One pound of ink should be mixed thoroughly with 9 pints of turpentine. This mixture should be added to 4 lb of melted beeswax and stirred vigorously. Allow this mixture to set for approximately 6 h before using.

Lithographic ink may also be mixed with bullet tipping paint to get additional distinctive colors. It is used mainly with yellow and orange paints.

AIR-TO-GROUND RANGE FLIGHT PROCEDURE

GENERAL

All air-to-ground attacks should be effectuated by a four aircraft flight.

NOTE

> It is suggested to change the personal, or the aircraft, radio call sign to an "operational" radio call sign as follows.
>
> All the formation: a definite short nick-name; as i.e. "tiger formation".
>
> The leader is therefore: "tiger one" or "tiger leader".
>
> The wingmen will be "tiger two, tiger three, tiger four". (brief and easy names like: lion, tiger, bear, fox, puma should be assigned to the formations).

No aircraft can enter the range area if it is not able to get in touch in a two way transmission with the range control tower, and must immediately leave the range if the radio transmission cannot be maintained.

RANGE CHECK IN PROCEDURE

Prior to arriving at the range, the flight leader will give the proper signal for the flight to assume an in-trail formation. This formation should be reasonably close so that the flight leader will have complete control of the flight, approximately three to four ship lengths between aircraft. The flight leader will advise the Range Control Officer of the flight call sign, the number and type or aircraft in the flight, and the type for mission to be flown i.e. "tiger" leader with three wingmen for skip bomb and low angle strafe". The Range Control Officer will then request the flight line up.

The flight leader will report first, giving the aircraft number too. The number two man will check in giving the same information in the same order, i.e. "tiger two, aircraft 040". The remaining members of the flight will follow the same procedure until all members of the flight have checked in. The Range Control Officer will then the advise flight of the range they will use and the traffic direction.

ENTERING RANGE TRAFFIC

Approaching the range, the flight leader will turn the flight for the spacing pass over the proper side of the range. This turn will be entered with the flight in trail formation. As the turn is completed, the flight leader will signal for echelon on the proper side for the range traffic direction (left echelon for right traffic, right echelon for left traffic). This formation should not be a tight show echelon, but rather a slightly loose formation so that all members will have a chance to check the range and trim their aircraft without danger of collision. The spacing pass should be accomplished so that prior to breaking up, the flight will reach the desired firing speed for the mission being flown, and can trim their aircraft at that speed. It is the flight leader's responsibility to insure that the minimum altitude restrictions for spacing passes be complied with.

Normally the spacing pass descends no lower than 2000 feet above the ground. As the flight leader passes over the target area, he will pitch up into a climbing turn to the proper pattern altitude on the downwind leg. Each member of the flight will take a three second spacing interval and individually follow the leader. The Range Officer will notify the flight leader, prior to his spacing pass, as to whether the safety panel for the range is red or white. If a red panel is showing, the spacing pass is continued, and each aircraft enters the pattern normally. However, the entire flight will not descend below spacing pass altitude until the panel is changed to white and the flight is cleared to fire by the Range Officer. The flight leader will relay the "clear to fire" order to his flight.

At no time will a pass be made on a range, whether dry pass or firing, when a red panel is being shown.

DEPARTING THE RANGE

The flight will leave the range when all armament is expended, the range period is over, or a member of the flight has given the minimum fuel call sign.

The flight leader will advise the flight when he is making his last pass, and upon completing this pass will pull up to a normal downwind leg. At a point where the base leg is normally started, he will leave the traffic pattern with a turn towards the home base, using 84 percent power or an airspeed of 240 kt. He will turn off all armament switches.

As each member of the flight completes his last pass and climbs onto the downwind leg he will follow the same procedure. After each member of the flight has given this call the flight leader will call for a radio channel change to squadron frequency and the flight will check in.

COMPUTING PATTERN CONDITIONS

In the following chapters on the different phases of air-to-ground weapon training, the patterns are discussed thoroughly with regard to size, dive angles, etc.

In your particular unit you may, because of terrain, or type of aircraft, find it necessary to vary from those outlined. The following diagrams may be used as a guide in computing your pattern size.

Remembering the simple trigonometrical function (Co-tan $\alpha = \frac{\text{adjacent}}{\text{opposite}}$) you can figure any information needed. All that is necessary is a set of natural trigonometric

PATTERN DATA AND SIGHT SETTING

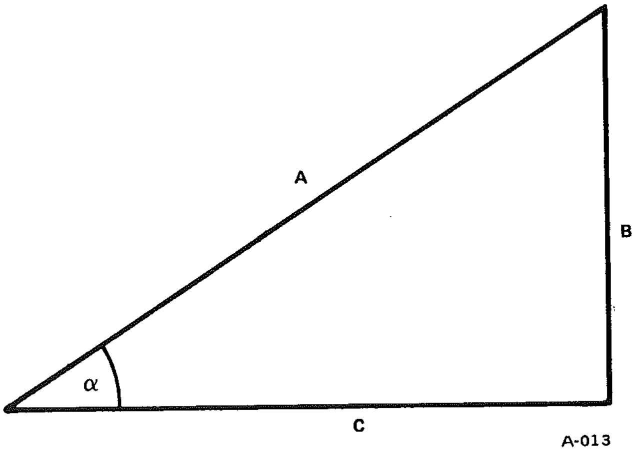


Figure 4-40.

function tables. For example. We want to find how our base leg must be from the target if we are firing in a 20 degree dive and the base leg altitude is 3000 ft above the ground level at the target. Now by filling in the formula we know that the

$$(C) = \text{Co-tan}\ \alpha \times B$$

$$(C) = 2.747 \times 3000$$

$$(C) = 8241 \text{ ft}$$

Now we can fill in distance C and can also see that if you have the dive angle of 20 degrees and you must set your base leg, because of some obstacle, at 7500 ft from the target that

$$(B) = C \times \tan \alpha \text{ or } \frac{C}{\text{Co-tan}} = \frac{7500}{2747} =$$

$$= 2730 \text{ ft AGL}$$

- Pull-up 4 g attained in 2 s.
- Aircraft mass at moment of firing = 8000 lb.
- Range elevation 0 ft - ground temp + 30°C.

WARNING

> Release altitude AGL calculated for a pull-up of 4 g only for target at sea level.
> For different target altitude recovery altitude may be below minimum safe altitude and the fig. 4-41 is therefore not suitable.

SKIP AND HIGH DRAG BOMBING

INTRODUCTION

Skip and high drag bombing will be normally conducted during the first part of air-to-ground gunnery training phase, in conjunction with low angle strafing missions. The armament for this type mission will be two practice bombs. The bombs should be dropped during the first part of the mission. Since all phases of the mission up to the traffic pattern itself have been covered, they will not be repeated in this paragraph.

PATTERN DATA

a. Base leg altitude: 2500 ft above the ground
b. Base leg airspeed: 250 kt
c. Power settings: 92 to 96 percent
d. Dive angle: zero degrees
e. Drop airspeed: 380 kt
f. Drop altitude: 35 ft
g. Minimum altitude: 35 ft
h. Minimum airspeed: 300 kt

SKIP BOMBING PATTERN

Rectangular traffic patterns are used. There will normally be four skip bombing targets on the range. The leader drops on the target the closest to the tower, number two drops on the next one out, etc. If less than four targets are available, the instructor will assign firing order for each target. With four aircraft in the pattern, the spacing between aircraft should be sufficient to allow a pilot to enter the firing run and sight on the target area without bringing his armament to bear on the preceding aircraft (fig. 4-42). Normally, this will mean that the aircraft turning onto the final approach will arrive at the proper position for his turn just as the preceding aircraft is completing his firing pass. At this time, the third aircraft will be approaching his turn onto the base leg, and the fourth aircraft will be completing his recovery onto the downwind leg. In order to maintain the proper spacing in the pattern, it may be necessary to vary the position of the downwind leg in relation to the range. If inadequate spacing exists, the downwind leg should be angled out, so that the following aircraft will cover more distance, thereby increasing the spacing. If excessive spacing exists, the following aircraft should attempt to "cut off" the preceding aircraft, so that the spacing will close up.

In either case, the base leg position should be sacrificed for spacing, nor should the following aircraft attempt to obtain proper position by changing airspeed, as this may result in a poor pass. If the following pilot is unable to gain proper position prior to entering the turn onto the base leg, he should complete the pass making a dry run if too close or a normal pass if too far back, and than correct the spacing for the next pass. At all times, all pilots will keep the aircraft ahead of them in positive sight.

SKIP AND HIGH DRAG BOMBING TECHNIQUES (fig. 4-43)

As the flight leader pulls up onto the downwind leg after the spacer pass, he will

PATTERN DATA AND SIGHT SETTING

FOR AIR-TO-GROUND PRACTICE MISSIONS

EVENT	BASE LEG			WEAPON RELEASE					MINIMUM SAFE ALTITUDE AGL FT		SIGHT SETT. MILS
	ALTIT. AGL FT	IAS KT	%	DEG	IAS KT	%	RELEASE ALTITUDE AGL FT	SLANT RANGE FT			
LOW ANGLE STRAFE	3500	240	82 ÷ 84	20	340	90 ÷ 95	500	1500	100	(3)	5
										(4)	5
ROCKETRY	7500	200	80 ÷ 82	40	370	90 ÷ 92	2500	3800	500	(5) (6)	21 16 17
HIGHT ANGLE BOMBING	9000	170	80 ÷ 82	50	380	78 ÷ 82	3500	4300	1000	(1)	80
										(2)	84
SKIP	2500	250	84 - 86	0	350	90 - 94	35	820	35	(1)	44
										(2)	45
HIGHT ANGLE STRAFE	8000	170	78 -	45	380	90 -	3000	4300	1000	(3) (4)	5 11

(1) Practice bomb, BDU33( )/B
(2) Practice bomb, MK23 and MK5
(3) Practice ammunition, cal .50 APM2
(4) Practice ammunition, cal .30 M59/M80
(5) SCAR 2.25
(6) FFAR 2.75, MK1 warhead
(7) SNIA-BPD 2" Rockets, inert warhead
(8) Sight depression: mils below the "gun" sight position line (preset in position 1 & 2 of the sight).

Figure 4-41.

SPACING IN THE PATTERN

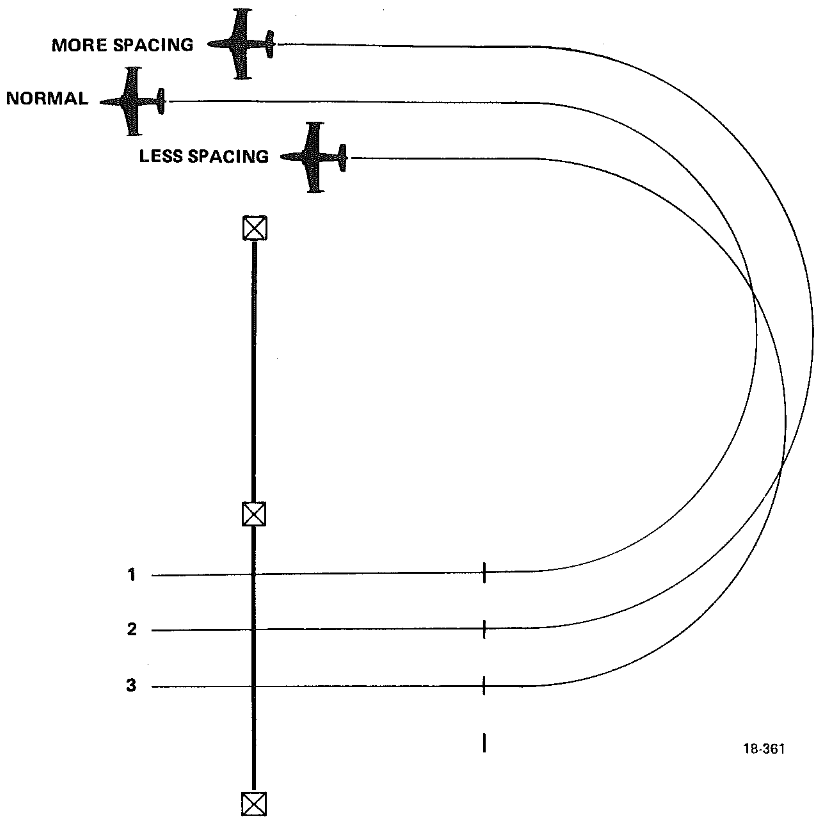


Figure 4-42.

call the flight to set up sights and switches for skip bombing. As you reach the downwind leg, turn the sight and the armament control panel to the required settings. You should be at an attitude of 2500 ft above the ground on the downwind and base legs and the power should be adjusted to approximately 85 percent to maintain 250 kt. The flight leader will establish the correct base leg position at a distance approximately 12 000 ft horizontally from the target. Just before the turning final, a mandatory radio call will be made by each pilot, giving the panel color. After turning onto the base leg, begin a nose down turn onto the final. Continue this descending turn to be lined up with the range and target, at an altitude of 300 ft above the ground as the turn onto final is completed, at least 5000 ft short of the drop point. This altitude and distance will allow for final maneuvering as you descend to the drop altitude. In lining up for the drop, you should line up the bomb to be dropped with the center of the target. The left bomb will drop on the first impulse from the bomb release button and you must allow for the fact that the bomb area is not directly under the sight line but 9 or 12 ft to the left and right of the sight line. A good reference for this linear difference is the post which holds the bomb target erect. When dropping the left bomb, align the sight pipper vertically just inside of the right post, and for the right bomb just inside the left post. This will allows maximum margin for error on both sides of the bomb. As you are aligning the pipper, you should be carefully adjusting your altitude to maintain the desired 35 ft above the ground.

As you level off at 35 ft (300 ft for high drag bombing) and look through your sight, you will see that the pipper is on the ground well in front of the target, and as you hold your aircraft in level flight approaching the target, the reticle will seem

SKIP BOMBING TECHNIQUES

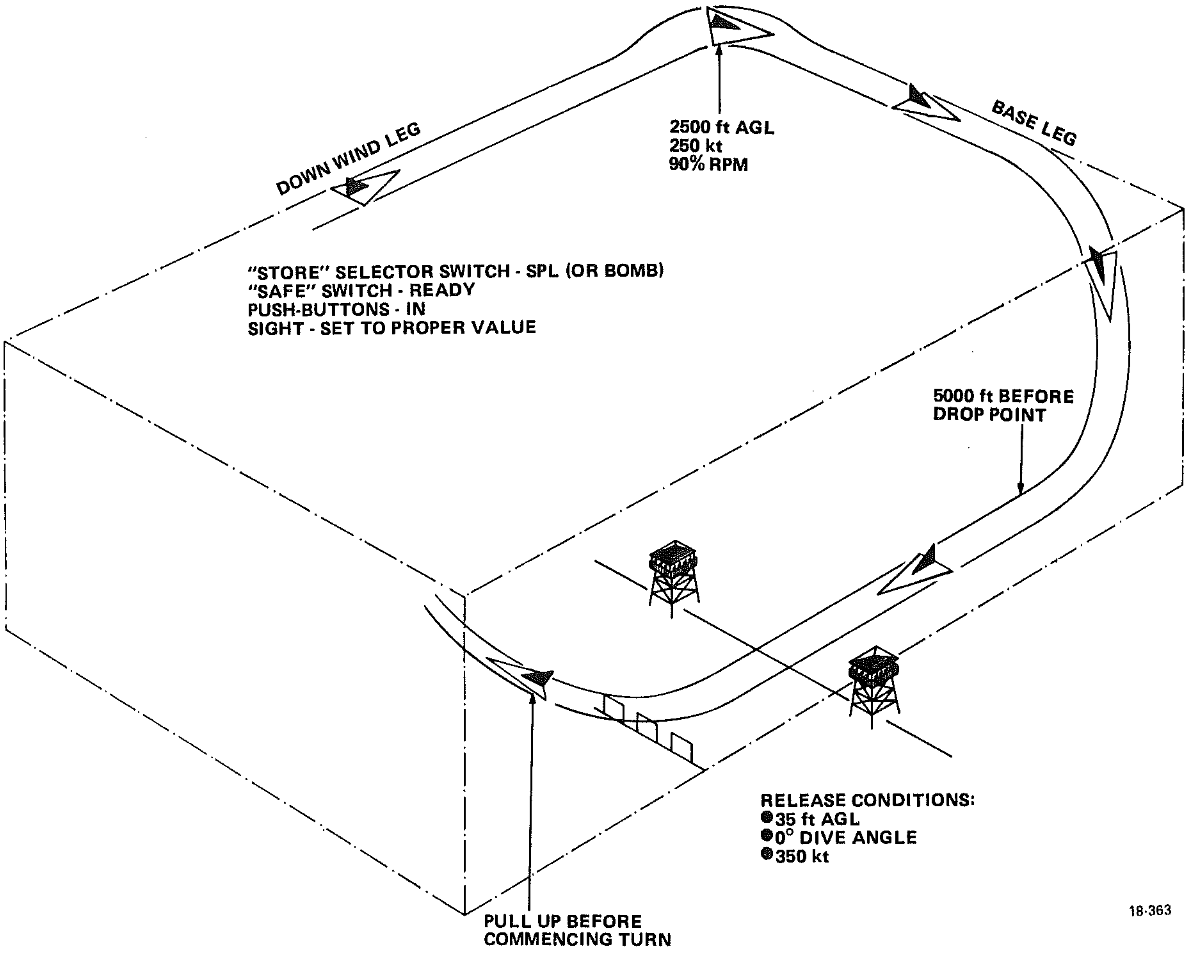


Figure 4-43.

to move forward along the ground.

When the center of the reticle moves to a position just within the bottom edge of the target, you are at the proper release point. Depress the bomb release button to release the bomb at that instant.

Since a "hit" is scored at any time the bomb touches the target a certain degree of latitude exists in the release conditions. The bomb may hit the ground and skip through the target, or hit the target on the fly, and both will be scored as hits.

One of the greatest single error factors in the skip bombing phase is the inclination to release in a slight dive or climb. Since the sight is rigid, the sight picture will not be accurate in these conditions and the forces acting on the bomb will not satisfy the conditions established for solution of the skip bombing problem.

Great care should be taken to prevent violation of the 35-foot minimum altitude. The reason for this is obvious, for safety wise as well as for increased accuracy.

The Range Officer informs each pilot as to where his bomb hits, and may give correction if necessary. Each pilot will acknowledge all calls form the Range Officer. If your first bomb missed the target, try to determine why, and correct the error on the next pass. Accurate error analysis is important in all gunnery training and particularly in this phase. In order to insure maximum accuracy in skip bombing, the exact dropping conditions outlined at the beginning of this chapter must be maintained. Variations of release conditions will alter the impact point of the bomb in the following manner:

a. OVERSPEED AT RELEASE

Overshoots the target

b. UNDERSPEED AT RELEASE

Undershoots the target

c. HIGH RELEASE ALTITUDE

Undershoots the target

d. LOWER RELEASE

Overshoots the target

e. DIVING RELEASE

Overshoots the target

f. CLIMBING RELEASE

Undershoots the target

g. POSITIVE "g" AT RELEASE

Undershoots the target

h. NEGATIVE "g" AT RELEASE

Overshoots the target

i. SKID

Line error in the direction of the ball.

Correcting for crosswind effect, in this problem, is relatively simple since the bomb will tend to follow the flight path of the aircraft even though the nose of the aircraft is crabbed into the wind. If the bomb is lined up with the target and the pipper is allowed to progress to the proper release point, all other conditions being normal, the bomb will hit the target. Head or tail wind will have little effect for this particular type of bombing pass. The rule of thumb for wind correction for skip bombing is to apply two mils correction, into the wind, for every knot of crosswind.

The recovery from the skip bomb pass is often the key to a well executed pattern. In recovering, the nose of the aircraft should be brought smoothly up to a climbing angle of approximately 40 degrees. After attaining this climb angle, the aircraft should be rolled into a turn in the direction of traffic and climb made to the downwind leg. After you have completed your skip bombing, place the ready-safe and the stores switches in the off position.

LOW ANGLE BOMBING TECNHIQUES
(fig. 4-44)

As the flight leader pulls up onto the downwind leg after the spacer pass, he will call the flight to set up sights and switches for low angle bombing. As you reach the downwind leg, turn the sight and the armament control panel to the required settings.

You should be at an altitude of 2500 ft above the ground on the downwind and the base leg, and the power adjusted to approximately 85 percent to maintain 250 KIAS. The correct base leg position is at 12 000 ft horizonatally from the target.

Just before turning, a mandatory radio call will be made by each pilot. After turning onto the base leg adjust power to 92% approx and begin a nose down onto the final. Continue the descending turn to be lined up with the target.

At 1500 ft AGL and 8600 ft slant range the turn onto final will be completed.

You are now approaching the target at 10° dive. Descend now to the drop altitude aiming first approximately 900 ft short of target and let the pipper walk up to target gently in order to have the pipper on the target at 1936 ft slant range, altitude AGL 500 ft, relase airspeed 380 KIAS. Great care should be taken to prevent going below 500 ft altitude and to pull up immediately after the bomb release.

Variation of the release conditions will alter the impact point of the bomb in the following manner:

a. OVERSPEED AT RELEASE

Overshoots the target

b. UNDERSPEED AT RELEASE

Undershoots the target

c. HIGH RELEASE ALTITUDE

Undershoots the target

d. LOWER RELEASE

Overshoots the target

e. DIVE ANGLE OVER 10 DEGREES

Overshoots the target

f. DIVE ANGLE UNDER 10 DEGREES

Undershoots the target

g. RELEASING OUT OF RANGE

Undershoots the target

h. RELEASING TOO CLOSE

Overshoots the target

i. POSITIVE "g" AT RELEASE

Undershoots the target

LOW ANGLE BOMBING TECHNIQUES

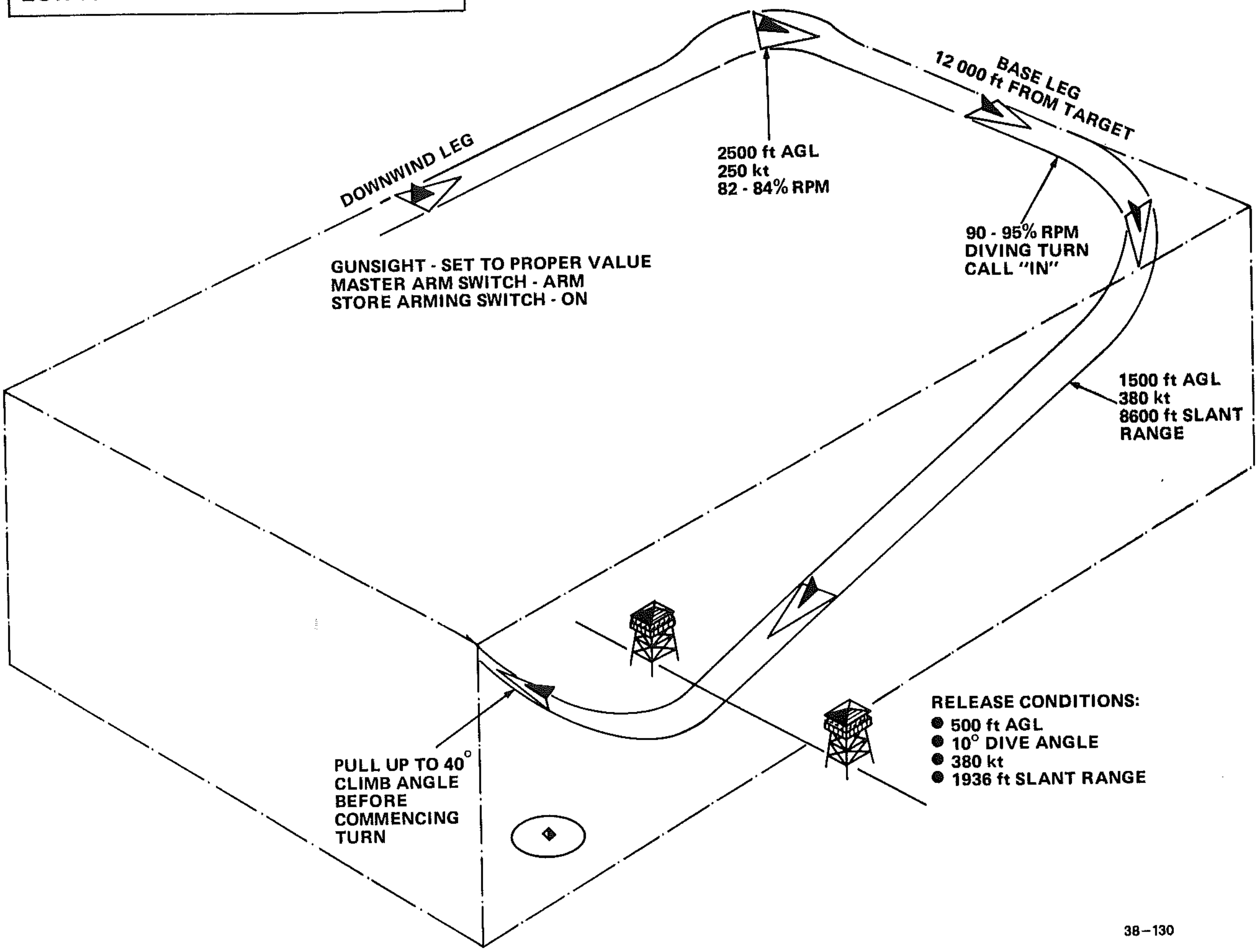


Figure 4-44.

l. NEGATIVE "g" AT RELEASE

Overshoots the target

m. SKID

Line error in the direction of the ball.

Correcting for crosswind effect, in this problem, is relatively simple since the bomb will tend to follow the flight path of the aircraft even though the nose of the aircraft is crabbed into the wind. If the bomb is lined up with the target and the pipper is allowed to progress to the proper release point, all other conditions being normal, the bomb will hit the target. Head or tail wind will have little effect for this particular type of bombing pass. The rule of thumb for wind correction for low angle bombing is to apply two mils correction, into the wind, for every knot of crosswind.

The recovery from the low angle bomb pass is often the key to a well executed pattern. In recovering, the nose of the aircraft should be brought smoothly up to a climbing angle of approximately 40 degrees. After attaining this climb angle, the aircraft should be rolled into a turn in the direction of traffic and climb made to the downwind leg. After you have completed your bombing, place the master arm and the stores switches in the Off position.

LOW AND VERY LOW ANGLE STRAFING

INTRODUCTION

Low angle strafing will be conducted during the first part of your air-to-ground gunnery training phase, in conjunction with skip bombing. The armament load will be: two guns loaded with a total of 180 rounds of 30 mm or 50 or 30 caliber ammo. Bombs and ammunition will be carried on each low angle mission and the strafing will be done after the bombs have been dropped. Since all phases of the mission up to the traffic pattern itself have been covered, they will not be repeated in this chapter.

PATTERN DATA

a. Base leg altitude: 3500 ft above the ground for guns, 2500 ft above the ground for cannons

b. Base leg airspeed: 240 kt.

c. Power setting: 90 to 95 percent.

d. Dive angle: 20 degrees; 15 degrees for cannons (7.5 degrees for very low angle strafing).

e. Firing airspeed: 380 kt.

f. Slant Range: 1500 to 1280 ft for cal .30 and cal .50 guns, 2200 ft for cannons.

g. Foul line: 1200 ft for guns; 1800 ft for cannons.

h. Minimum recovery altitude: 100 ft.

LOW ANGLE STRAFING PATTERN

The pattern for low angle strafing is similar to that used for skip bombing.
The general procedures for flying the pattern that were mentioned in the skip bombing chapter are also applicable to the strafing pattern. One significant difference in the pattern is that you maintain your base leg altitude until you are in your turn onto the final.
The flight leader will pull up onto the downwind leg for the strafing pattern and remind all the flight members to set up sights and switches for low angle strafing. The spacing in the pattern will remain the same. The base leg position will be slightly closer to the target area than that used for skip bombing in order to achieve the desired dive angle form the base leg altitude used. The base leg for low angle strafing should be 9610 ft horizontally from the target for guns and 9330 ft for cannons.

LOW ANGLE STRAFE

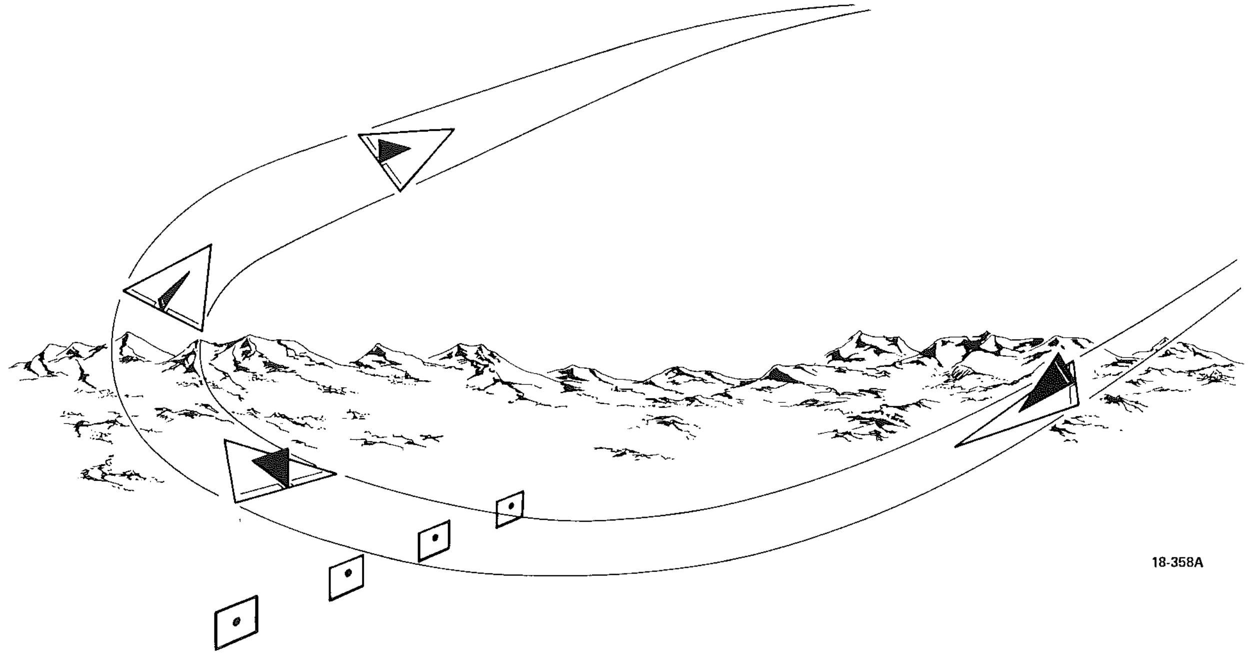


Figure 4-45.

Proper airspeed, altitude and power should be established on the base leg. The normal radio call will be made just prior to turning onto the final and you should absérve the armament control panel before making the call.

The targets are numbered: you will fire on the target corresponding to your position in the flight (leader on number 1 target, two on 2, etc.).

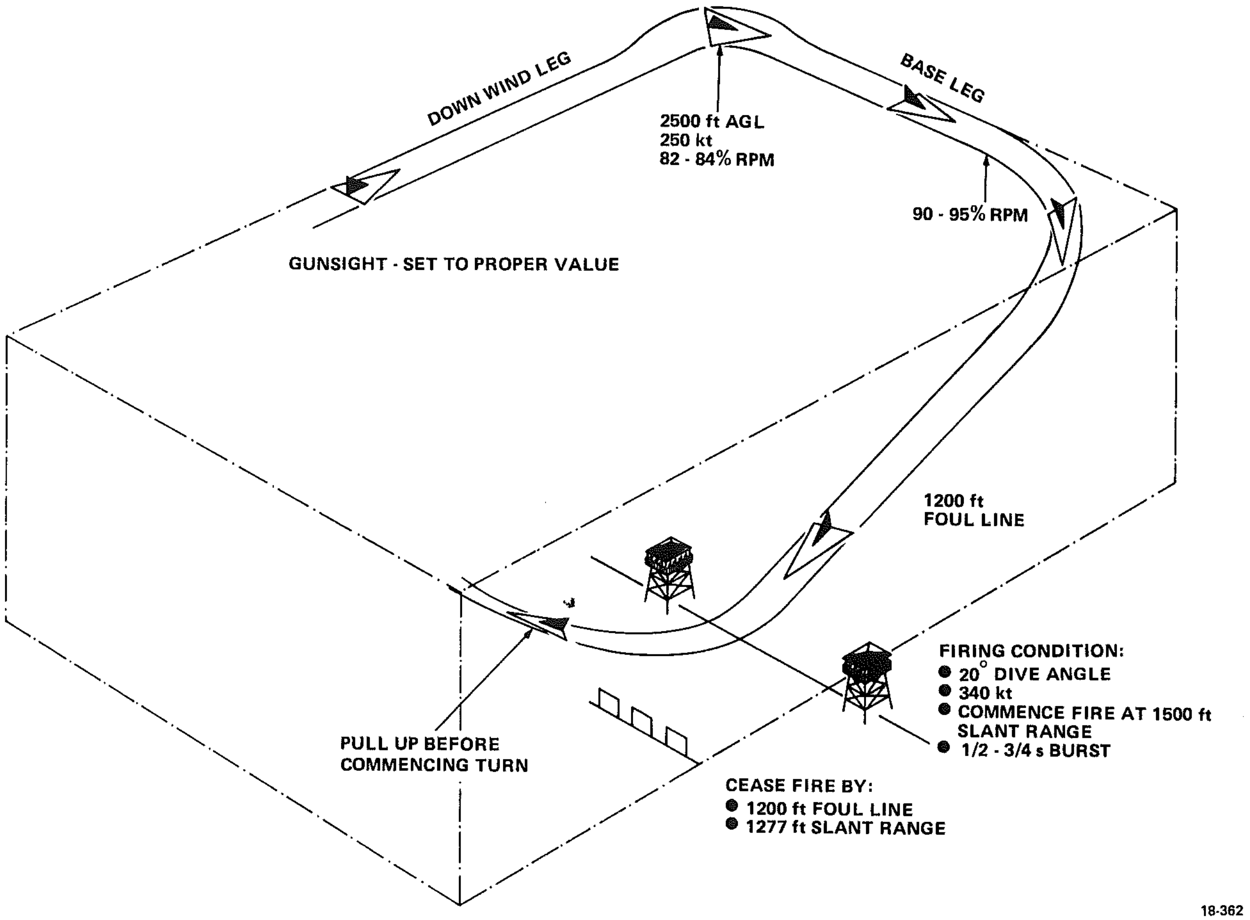
Minimum recovery altitude for low angle strafing is 100 ft above the ground. If you can cease firing when you reach the foul line, there will be no tendency to make low pullsouts. It is suggested that, on the first two low angle strafing firing missions for each student, the guns will be loaded with tracer ammunition to impress him with the ricochet hazard.

LOW ANGLE STRAFING TECHNIQUES
(fig. 4-46, 4-47 and 4-48)

The flight leader calls to set up the switches and sights for low angle strafing: you have to comply with. Attain a downwind leg altitude and adjust the power to maintain 250 kt (82 to 84 percent). The flight leader will establish the base leg correct position and it is important that you place your base leg in the same position. Maintain 250 kt and 2500 ft altitude on the base leg. Before turning final, make the normal radio call giving range in use and panel color. After completing the radio call, set power to 90 to 95 percent.

Begin a level turn onto the final, and in order to achieve the angle of dive desired for the pass, no altitude should be lost un-

LOW ANGLE STRAFING TECHNIQUES - MACHINE GUNS



FIRING CONDITION:
- 20° DIVE ANGLE
- 340 kt
- COMMENCE FIRE AT 1500 ft SLANT RANGE
- 1/2 - 3/4 s BURST

CEASE FIRE BY:
- 1200 ft FOUL LINE
- 1277 ft SLANT RANGE

Figure 4-46.

LOW ANGLE STRAFING TECHNIQUES - CANNONS

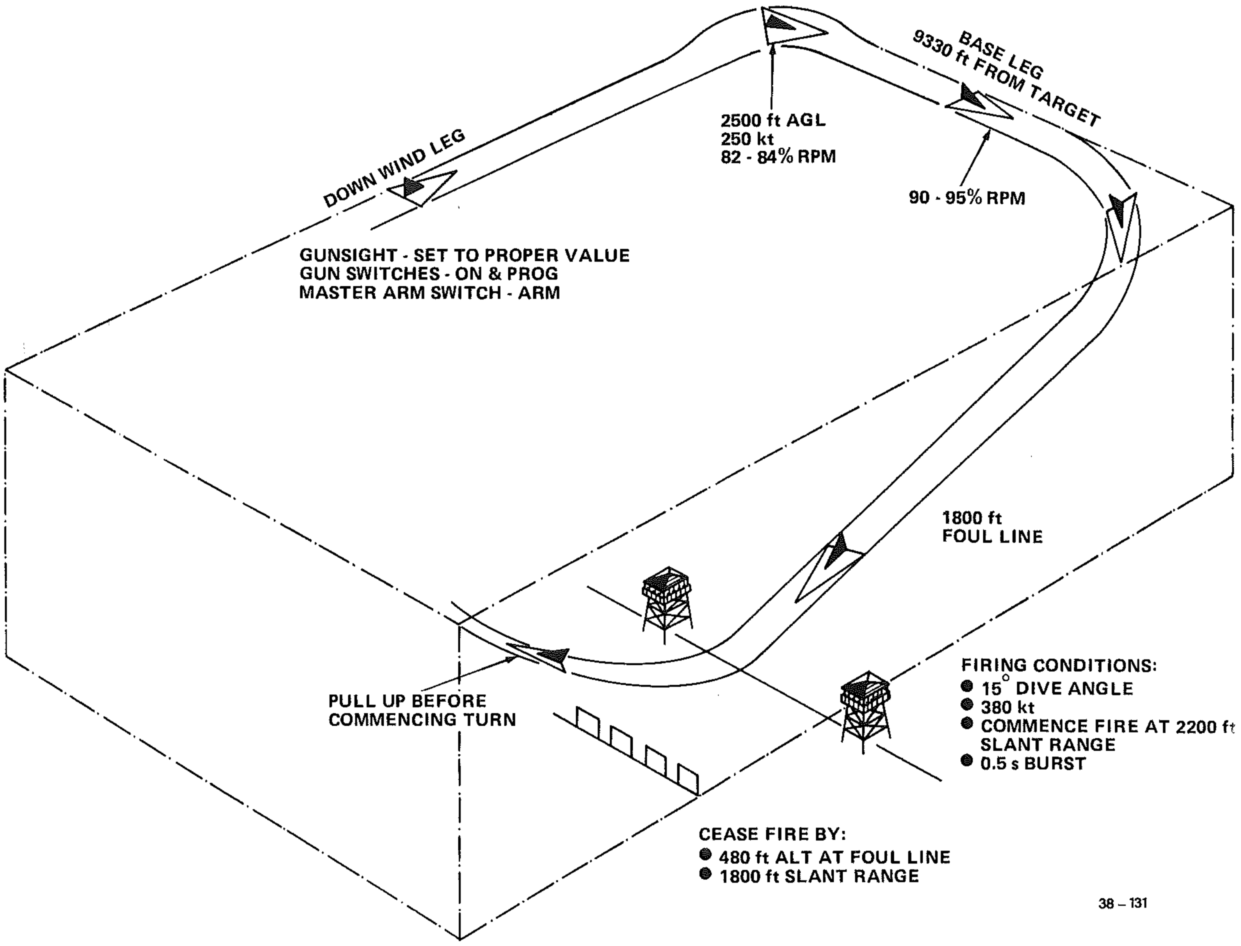


Figure 4-47.

til the nose of the aircraft is approximately three-fourths of the way around the turn. A poorly executed entry turn will decrease your ability to achieve the desired firing conditions. Roll out of the turn with the target in the windscreen. Upon completion of the turn, the pipper is placed at the six o'clock position to the target, so that you will not fly a humped path to keep the pipper on the target as you approach firing range. The pipper will be moved smoothly towards the target as the range decreases. As you reach the desired open fire range 1500 ft (2200 ft for cannons strafe) in a non-wind condition, the pipper should be on the bulls-eye of the target. The most accurate method of recognizing the open fire range is by comparing the size of the pipper with 36-inch bulls-eye on the target. The foul line is normally marked on the ground, but since the intense concentration necessary to hold a good aiming point takes all of your attention, you should not try to use the foul line for range estimation. When you have achieved the proper sight picture, fire a short burst and begin your recovery. The firing airspeed should be 380 kt, and the minimum recovery altitude is 100 ft above the ground. If you open fire at 1500 ft (2200 ft for cannon strafe) and fire a short burst, there is no danger of firing past the foul line.

There is no restriction on the maximum "open fire" range, but it must be remembered that the greater the range, the greater the bullet dispersion and gravity drop,

VERY LOW ANGLE STRAFING TECHNIQUES - CANNONS

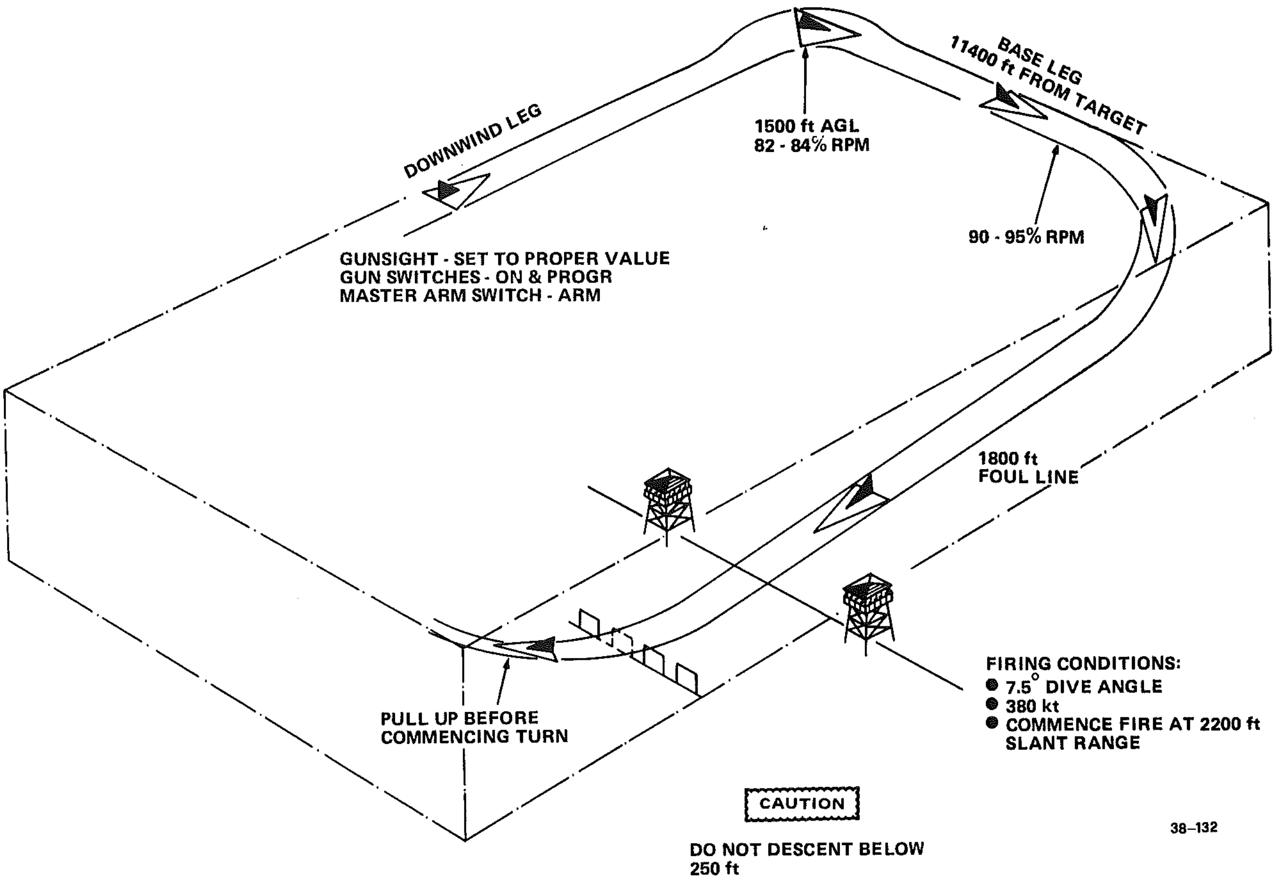


Figure 4-48.

thus decreasing your accuracy. If you fire closer than the foul line there is danger of flying into the target, making a low pull-out and mushing into the ground, overstressing the aircraft and/or damaging the aircraft by a ricochet.

The most effective method of wind correction is to aim the pipper into the crosswind at a rate of one-half mil per knot of crosswind. Observe the results of your first firing pass and make necessary correction. Place the pipper into the wind when you first roll out on the final and allow it to drift, so that by the time you are at firing range, your sight will be at the desired aiming point.

Variations from the standard firing conditions will alter the impact point in the following manner.

a. OVERSPEED

Overshoots the target

b. UNDERSPEED

Undershoots the target

c. FIRING OUT OF RANGE

Undershoots the target.

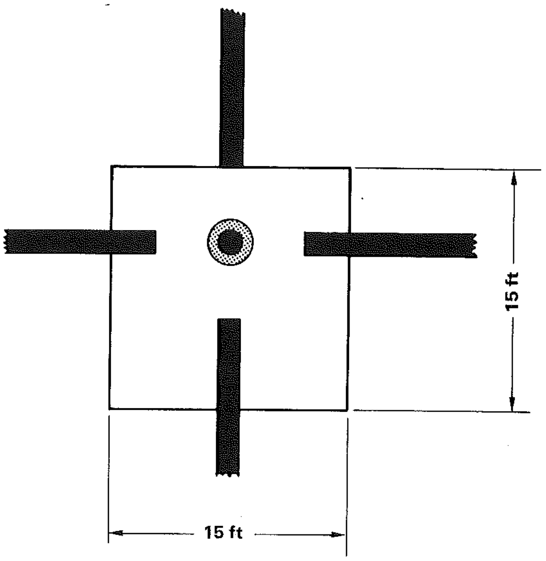
d. FIRING IN TOO CLOSE

Overshoots the target.

e. DIVE ANGLE OVER 20 DEGREES

Overshoots the target.

LOW ANGLE STRAFING SIGHT PICTURE



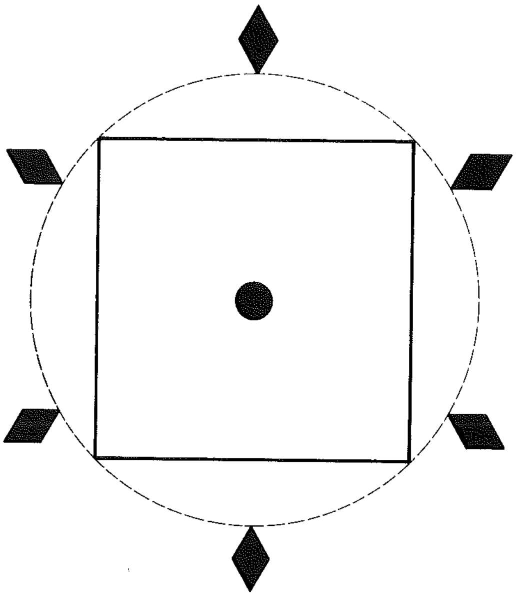
38-119

AERITALIA 8-105-924 GUNSIGHT ([B] AIRCRAFT)

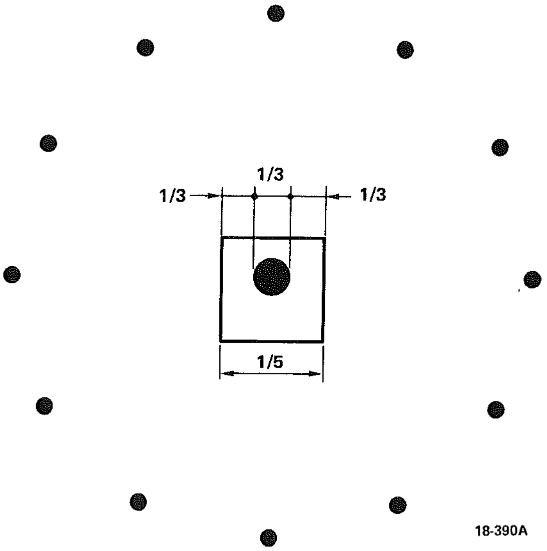
AT 1500 ft SLANT RANGE THE PIPPER APPEARS TO BE HAVE HALF THE BULLSEYE SIZE AND THE CROSS UPPER BAR IS TANGENT TO THE TARGET UPPER EDGE.

THOMSON R322Z(M) GUNSIGHT ([A] AIRCRAFT)

SET THE CIRCLE INSCRIBING THE DIAMONDS TO THE MINUM SIZE.
AT 2000 ft SLANT RANGE THE SIZE OF THE CIRCLE APPEARS TO BE EQUAL TO THE SIZE OF THE TARGET.
AT 1500 ft SLANT RANGE THE PIPPER APPEARS TO HAVE THE SAME SIZE OF THE BULLSEYE.



38-118



18-390A

THOMSON-CSF RD21 GUNSIGHT ([B] AIRCRAFT)

AT 2200 ft SLANT RANGE THE CENTRE DOT APPEARS TO HAVE APPROX. 1/3 THE SIZE OF THE TARGET, OR THE DOTTED CIRCLE IS 5 TIMES WIDER OF THE TARGET.
AT 1500 ft SLANT RANGE THE PIPPER APPEARS TO HAVE THE SAME SIZE OF THE BULLSEYE.

Figure 4-49.

f. DIVE ANGLE UNDER 20 DEGREES

Undershoots the target

g. POSITIVE "g"

Undershoots the target

h. NEGATIVE "g"
Overshoots the target.

i. SKID

Line error in the direction of the ball.

Observe the impact point on the ground, analyze the pass and make the necessary corrections in your next pass to put the entire burst through the target.
The recovery from the strafing pass is much like the one used for skip bombing: pull smoothly up until 40 degrees above the horizon, before commencing the turn to the downwind leg. If recovery minimum are observed there will be little tendency to overstress the aircraft.

ROCKETRY

INTRODUCTION

Rocket missions are normally run in conjunction with the high angle strafing missions. In this case the rockets will always be fired first and the remainder of the mission will be spent high angle strafing. Four FFAR, inert head will be carried on each mission. A sufficient number of rocket passes will be made for you to fire the rockets before the strafing passes are begun. When carrying rockets, it should be remembered that flaps are not lowered until the rockets have been armed. Since all other phases of the mission up to the pattern itself are the same on all air-to--ground mission , they will not be repeated in this chapter.

PATTERN DATA

a. Base leg altitude: 7000 ft above the ground.

b. Base leg airspeed: 200 kt.

c. Power setting: 90 percent, speed brakes in.

d. Dive angle: 30 degrees

e. Slant range: 4150 ft.

f. Firing altitude: 2500 ft AGL.

g. Firing airspeed: 380 kt.

h. Climb power setting: 98 percent.

i. Minimum recovery altitude: 1000 ft above ground.

ROCKETRY PATTERN

A rectangular pattern will be used

The spacing pass will be made at rocket firing airspeed (380 kt), and each pilot will carefully trim his aircraft at that airspeed. You must increase power to pull up in order to attain the base leg altitude at the proper airspeed. The flight leader will call the flight to set up sight and switches for rocket firing when on the downwind leg. The flight leader will set the base leg in the correct position to insure that the proper dive angle is obtained. In rocketry the base leg is 10 400 ft from the target. You should be certain that the base leg conditions for airspeed and altitude are correct before beginning the turn onto final. Normal spacing will be maintained in the pattern at all times, and the radio call and final power reduction should be made prior to turning onto the final.
The entry is begun by flying the sight from the horizon directly to the vincity of the target. Approximately three-fourths of the turn should be completed before you start to lose altitude. The first pass should be a dry run to allow the pilot to check the trim and firing conditions. You should never remove your left hand from the throttle during the pass as speed brakes may be needed if excess airspseeds are inadvertently attained.
Locate all other aircraft in the pattern as you climb on to the downwind leg. While on the downwind, check to see that the rocket sequence switch is set on SINGLE. All changes of switches will be made on the downwind leg, and you should never have your head in the cockpit while turining final or while on the final approach.

ROCKETRY TECHNIQUES (fig. 4-50)

On the first downwind leg, when advised by the flight leader to set up switches and sight for rockets, perform the following and sight desired depression, place the rocket switch in the "single" position. Attain the base leg altitude of 6000 ft above the ground and turn base leg to the position set by the flight leader, maintaining 200 kt. As you approach the turn to final, check the ground control panel, and make the radio call. As you turn final adjust power to 90 percent.
Make a level turn onto the final, dropping the nose when almost three-quarters

ROCKETRY TECHNIQUES

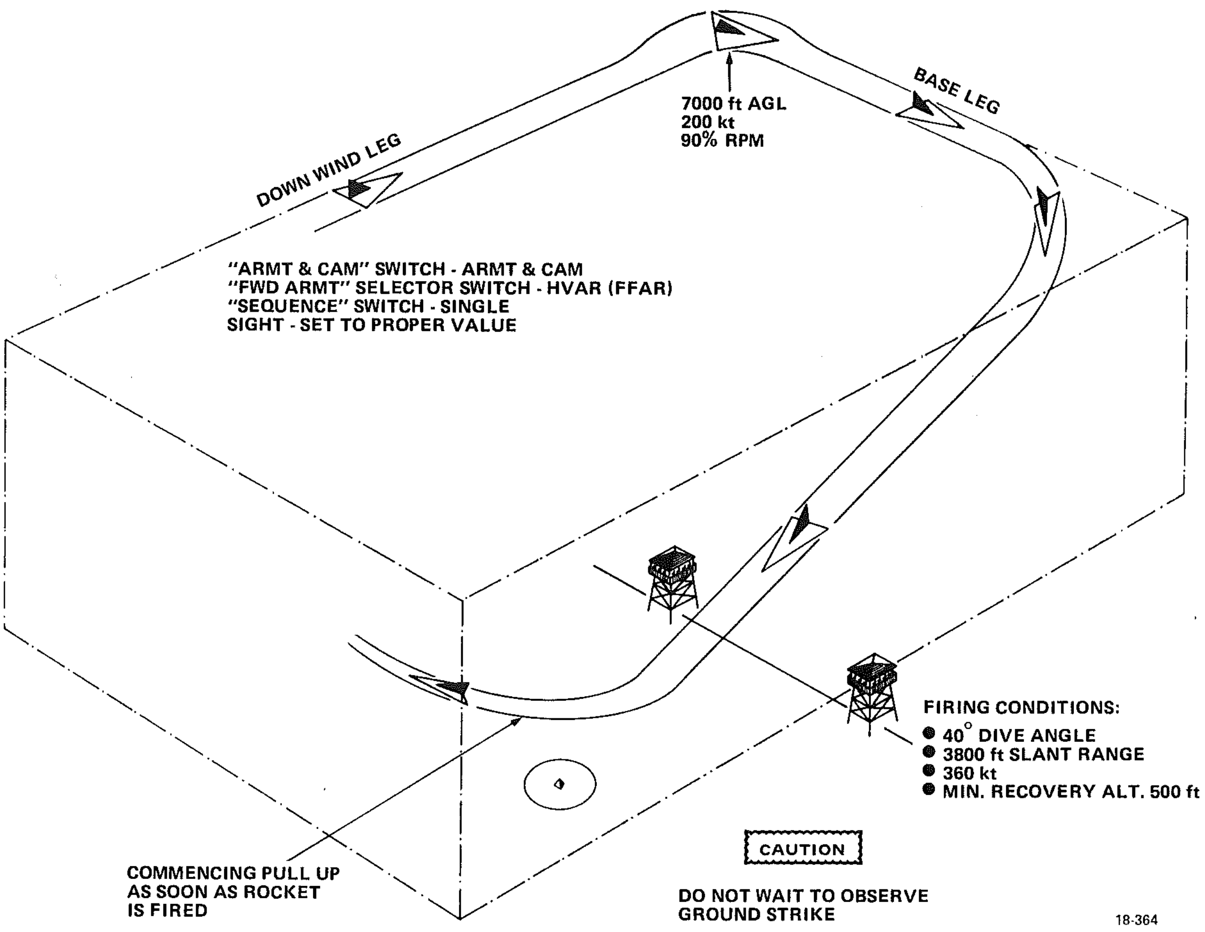

DOWN WIND LEG
7000 ft AGL
200 kt
90% RPM
BASE LEG
"ARMT & CAM" SWITCH - ARMT & CAM
"FWD ARMT" SELECTOR SWITCH - HVAR (FFAR)
"SEQUENCE" SWITCH - SINGLE
SIGHT - SET TO PROPER VALUE
FIRING CONDITIONS:
● 40° DIVE ANGLE
● 3800 ft SLANT RANGE
● 360 kt
● MIN. RECOVERY ALT. 500 ft
CAUTION
DO NOT WAIT TO OBSERVE GROUND STRIKE
COMMENCING PULL UP AS SOON AS ROCKET IS FIRED
18-364

Figure 4-50.

through the turn. Bring the sight directly to the vicinity of the target, placing the pipper slightly below the target and letting it "walk-up" as the airspeed increases and range decreases.

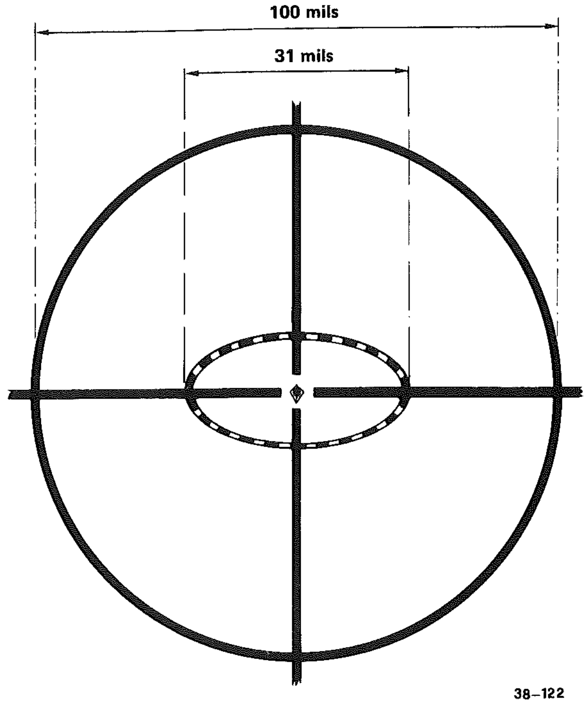
On a correct rocket pass with the speed of the aircraft rapidly increasing and the slant range decreasing, the sight will "walk-up" to the bulls-eye and arrive there just as you reach the firing point. Usually, you will fly a curve and will find that it may require slight forward pressure on the stick to hold the pipper on the bull at time of firing. Trimming your aircraft for the firing conditions during your first dry run will minimize this effect and increase the effectiveness of your pass.

As the pipper approaches the bull, check the reticle size and compare it with the 150 foot circle on the ground. As the reticle becomes superimposed on the target circle, as in figure 4-51, you are at the correct slant of 3800 ft. If your aiming point is correct, fire the rocket.

After you have fired your rocket, immediately commence your pull out, as the minimum recovery altitude is 500 ft. As soon as the nose of the aircraft is well above the horizon apply sufficient power and start your climbing turn to the downwind leg. The Range Officer will call your hits as soon as they have been plotted. All calls received from the Range Officer must be acknowledged. You should analyze the results of each pass and correct any errors in aiming point and firing conditions to improve your hits.

As you roll out in the downwind leg, check

ROCKETRY SIGHT PICTURE



38-122

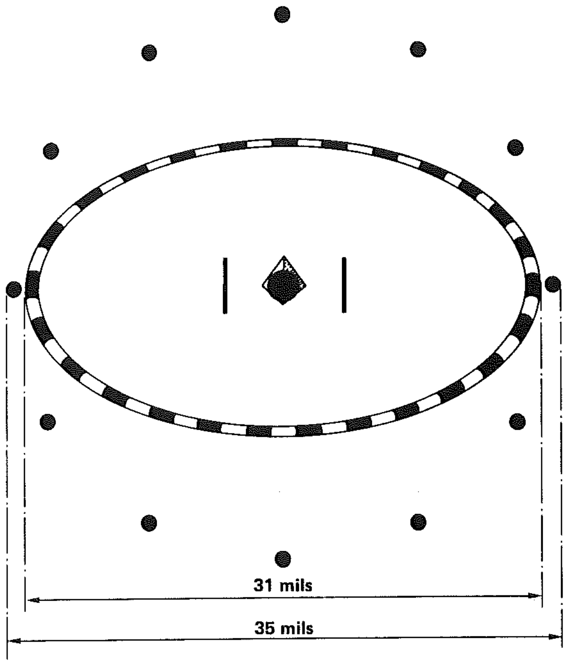
AERITALIA 8-105-924 GUNSIGHT ([B] AIRCRAFT)

AT 4800 ft SLANT RANGE AND 30° DIVE ANGLE THE TARGET APPEARS LIKE IN FIGURE.

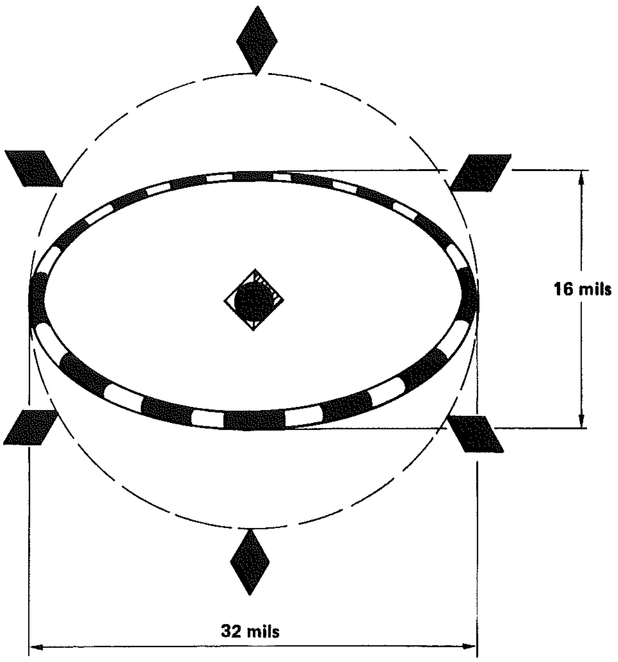
THOMSON R322Z(M) GUNSIGHT ([A] AIRCRAFT)

- SET TARGET SPAN DRUM TO 30 ft.
- SET RANGE DRUM TO READ ON THE SIGHTING HEAD A NOMINAL RANGE of 320 yd.

AT 4800 ft SLANT RANGE AND 30° DIVE ANGLE THE DIAMOND INSCRIBING THE CIRCLE IS COINCIDENT WITH THE TARGET MAJOR AXIS.



38-120



38-121

THOMSON-CSF RD21 GUNSIGHT ([B] AIRCRAFT)

AT 4800 ft SLANT RANGE AND 30° DIVE ANGLE THE TARGET APPEARS LIKE IN FIGURE.

Figure 4-51.

that the armament panel is properly set for the next rocket to be fired.

If any rockets do not fire, continue to fire the remaining rockets. Dive angle, slant range and airspeed are the most important variables in rocketry, but other causes can affect the trajectory of the rocket. Varying any of these conditions will cause an error. Factors that affect the rocket at the time of firing are listed below:

a. OVERSPEED

   Overshoots the target.

b. UNDERSPEED

   Undershoots the target.

c. FIRING OUT OF RANGE

   Undershoots the target.

d. FIRING IN TOO CLOSE

   Overshoots the target.

e. DIVE ANGLE OVER 30 DEGREES

   Overshoots the target.

f. DIVE ANGLE UNDER 30 DEGREES

   Undershoots the target.

g. POSITIVE "g"

   Undershoots the target.

h. NEGATIVE "g"

   Overshoots the target.

i. SKID

   Line error in the direction of the ball.

On each rocket pass, correct for the errors (if any) that you made on the last pass. In a cross wind your attack should be planned so that at the instant the rocket is fired, the pipper is displaced one mil per knot into the crosswind. Begin the recovery immediately after firing: if you delay to see where the rocket hits, your pull-out will be below the 500-foot minimum.

HIGH ANGLE STRAFING

INTRODUCTION

High angle strafing should be normally conducted in conjunction with rocketry missions. Armament load for high angle strafing should be 180 rounds of .50 in. caliber or caliber 30 mm ammunition, loaded 90 rounds per gun in two guns. Strafing will be done after the rockets have been fired. Since all phases of the mission up to the traffic pattern itself have already been covered, they will not be repeated in the chapter.

PATTERN DATA

a. Base leg altitude: 8000 ft above the ground.

b. Base leg airspeed: 170 kt.

c. Power setting at firing: 88 percent, speed brake in.

d. Dive angle: 40 degrees.

e. Release altitude: 3000 ft.

f. Slant range: 4670 ft.

g. Firing airspeed: 380 kt.

h. Climb power: 98 percent.

i. Minimum recovery altitude: 1000 ft above the ground.

HIGH ANGLE STRAFING PATTERN

The flight leader will bring the flight across the range in loose echelon formation on a spacer pass, and each member will break into the pattern on three second intervals. Power must be added to reach the base leg altitude at the proper airspeed. As the flight leader reaches the downwind leg, he will call the flight to set-up switches and sights for strafing.

The flight leader will establish the base leg at the proper position, and all pilots will strive to maintain this position, in order to attain the proper dive angle. For high angle strafing, the base leg is 9500 ft horizontally from the target.

As each flight member turns onto the final approach to the target, he will observe the control panel on the ground, make his radio call, and make final power adjustment for the strafing run. After achieving the proper sight picture and firing a short burst, a smooth pull-up will be made.

As the aircraft nose passes through the horizon, increase power for the climb back to base leg. Begin the turn, in the direction of traffic, only after the aircraft is climbing. While climbing locate all other aircraft in the pattern and establish proper spacing behind the preceding aircraft.

HIGH ANGLE STRAFING TECHNIQUES (fig. 4-52)

When advised by the flight leader, set-up switches and sight for high angle strafing. Attain base leg altitude of 8000 ft above the ground and turn onto the base leg at the position set-up by the flight leader. You

HIGH ANGLE STRAFING TECHNIQUES

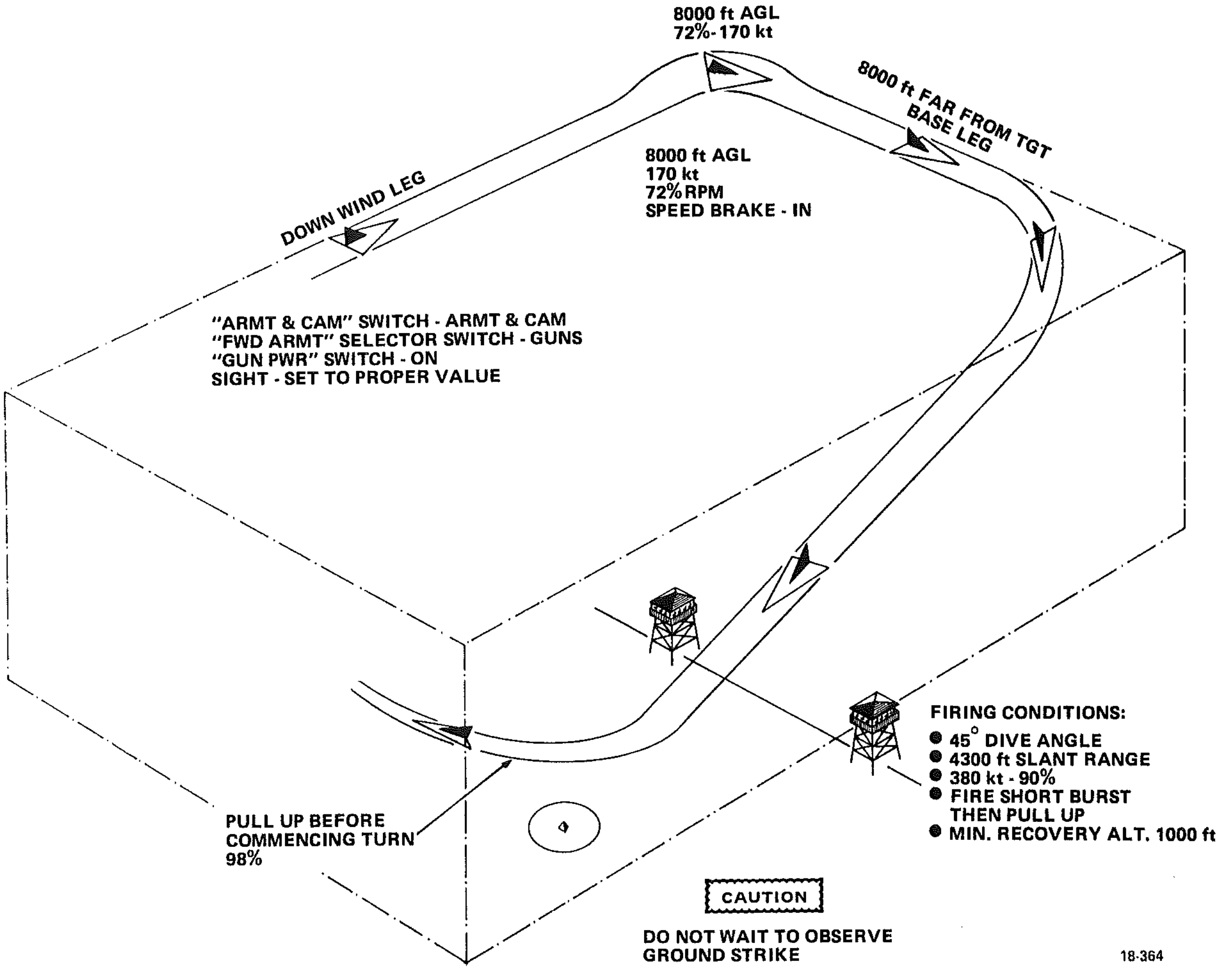

8000 ft AGL
72%-170 kt
8000 ft FAR FROM TGT BASE LEG
8000 ft AGL
170 kt
72% RPM
SPEED BRAKE - IN
DOWN WIND LEG
"ARMT & CAM" SWITCH - ARMT & CAM
"FWD ARMT" SELECTOR SWITCH - GUNS
"GUN PWR" SWITCH - ON
SIGHT - SET TO PROPER VALUE
FIRING CONDITIONS:
● 45° DIVE ANGLE
● 4300 ft SLANT RANGE
● 380 kt - 90%
● FIRE SHORT BURST THEN PULL UP
● MIN. RECOVERY ALT. 1000 ft
PULL UP BEFORE COMMENCING TURN 98%
CAUTION
DO NOT WAIT TO OBSERVE GROUND STRIKE
18-364

Figure 4-52.

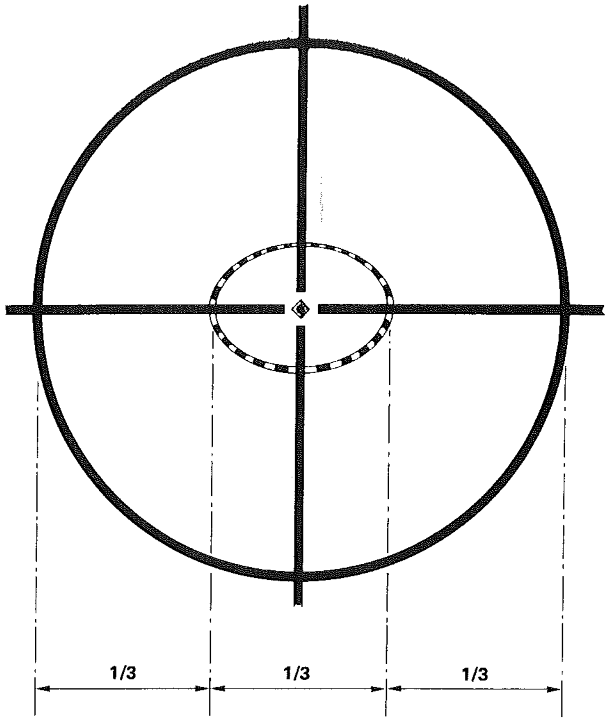
should maintain 170 kt airspeed on the base leg. As you approach the turn to final, check the color of the ground control panel and make your radio call. As you turn onto the final, adjust power to 90 percent.

Use a wing-over type of turn onto the final and pull the nose of the aircraft down to a point just below the target. This places the pipper well below the target and avoids the necessity of pushover to obtain the sight picture after aligning the target on the final approach. As the airspeed increases and the slant range decreases, allow the sight to move up to the target. As the sight approaches the target you will notice that the reticle is larger than the 150-foot circular target on the ground. Fly the sight pipper up until it is directly over the bulls-eye, and at this time you should be approaching the correct slant range. Hold the pipper on the bulls-eye and as the reticle superimposes itself to the target as shown in fig. 4-53 you are in range.

Sufficient rounds should be fired so that the impact will raise enough dust for the plotters to score the hit, however do not hold the dive so long that you descend below the 1000-foot minimum altitude on pullout.

You should fire at 4670 ft slant range and 380 kt airspeed. As you pull the nose of the aircraft above the horizon, increase the power to 98 percent for the climb back to base leg altitude. Be sure that the aircraft is definitely climbing before beginning the turn in the direction of traffic. Locate all aircraft in the gunnery pattern as you climb to the base leg altitude and gain pro-

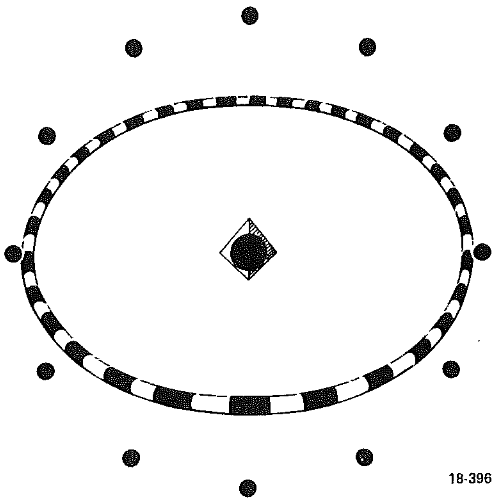
HIGH ANGLE STRAFE SIGHT PICTURE



THOMSON R322Z(M) GUNSIGHT ([A] AIRCRAFT

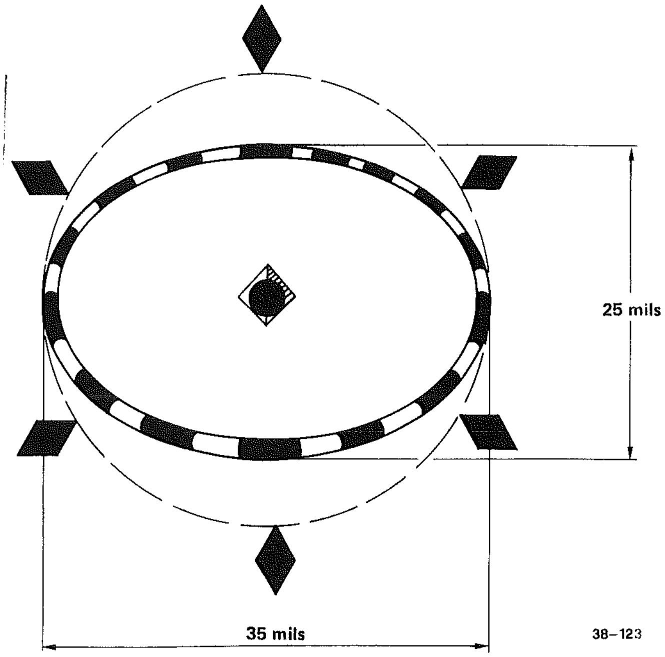
- SET TARGET SPAN DRUM TO 30 ft.
- SET RANGE DRUM TO READ ON THE SIGHTING HEAD A NOMINAL RANGE OF 287 yd.

AT 4300 ft SLANT RANGE AND 45° DIVE ANGLE THE DIAMOND INSCRIBING THE CIRCLE IS COINCIDENT WITH THE TARGET MAJOR AXIS.



AERITALIA 8-105-924 GUNSIGHT ([B] AIRCRAFT)

AT 4300 ft SLANT RANGE AND 45° DIVE ANGLE THE DIAMETER OF THE SIGHT CIRCLE APPEARS TO BE 3 TIMES LARGER THE TARGET MAJOR AXIS.



THOMSON-CSF RD21 GUNSIGHT ([B] AIRCRAFT)

AT 4300 ft SLANT RANGE AND 15° DIVE ANGLE THE DOTTED CIRCLE OF THE SIGHT APPEARS EXTERNALLY TANGENT TO THE TARGET MAJOR AXIS.

Figure 4-53.

per spacing.

When performing high angle strafing the sight picture is used to determine the slant range. Both dive angle and airspeed in excess of that required causes an overshoot condition. In a no wind condition, firing in a 45 degree dive, at 380 kt, and at 4670 ft slant range, you will hit the bulls-eye provided the sight pipper is on the target. Varying any of these conditions will cause an error. Effects of these conditions are as follows:

a. OVERSPEED

Overshoots the target.

b. UNDERSPEED

Undershoots the target.

c. FIRING OUT OF RANGE

Undershoots the target.

d. FIRING IN TOO CLOSE

Overshoots the target.

e. DIVE ANGLE OVER 45 DEGREES

Overshoots the target.

f. DIVE ANGLE UNDER 45 DEGREES

Undershoots the target.

g. POSITIVE "g" WHILE FIRING

Undershoots the target.

h. NEGATIVE "g" WHILE FIRING

Overshoots the target.

i. SKID WHILE FIRING

Line error in the direction of the ball.

The Range Officer will call each hit in footage distance from the bulls-eye and indicate the clock position as soon as it is plotted. Acknowledge each call and then analyze your pass to correct your firing conditions and aiming point. If you have an error, make a correction for it, on the next pass. Put your base leg in the proper place to insure that you have a 45 degree dive angle. Find the power setting that will give you the correct airspeed and use it on each pass. Your slant range is determined by your sight picture: so be certain that you have the correct sight picture when firing. Good trim techniques and good tracking before firing will eliminate the necessity to hold positive or negative "g" while firing. If there is a wind on the range, make a correction for it, by using 1/2 mil per knot of lead into the crosswind.

HIGH ANGLE DIVE BOMBING

PATTERN DATA

a. Base leg altitude: 8000 ft above the ground.

b. Base leg airspeed: 170 kt.

c. Power setting: 88 percent, speed brake in.

d. Dive angle: 40 degrees

e. Slant range: 4150 ft.

f. Drop altitude and airspeed: 3000 ft AGL - 380 KIAS.

g. Climb power: 98 percent.

h. Minimum recovery altitude: 1000 ft above the ground.

HIGH ANGLE DIVE BOMBING PATTERN

Rectangular traffic patterns will be used. The flight leader will bring his flight across the range in loose echelon on a spacing pass, and each member will break up into the pattern at three second intervals. One hundred percent power will be used to climb to base leg altitude. The spacing pass will be made at bomb release airspeed to allow for trimming the aircraft.

As the flight leader reaches to downwinds leg, he will call the flight to set-up switches and sights for bombing. The flight leader will establish the correct base leg position and each pilot will strive to maintain this position. In high angle dive bombing, the base leg is 9600 ft horizontally from the target for the 40 degree dive. As each flight member turns onto the final approach to the target, he will observe the control panel on the ground and make his radio call. He will then adjust the power for his bombing run, remembering to reduce power to prevent excessive speeds. After achieving the proper sight pictures and releasing the bomb, a smooth pull-up will be started. As the nose of the aircraft passes through the horizon, increase the power to 98 percent. Begin a turn in the direction of traffic only after the aircraft is climbing. While climbing locate all other aircraft in the pattern and establish proper spacing.

HIGH ANGLE DIVE BOMBING TECNIQUES (fig. 4-54)

When advised by the flight leader set up switches and sight for bombing. Attain a base leg altitude of 8000 ft above the ground and turn onto the base leg at the

HIGH ANGLE DIVE BOMBING TECHNIQUE

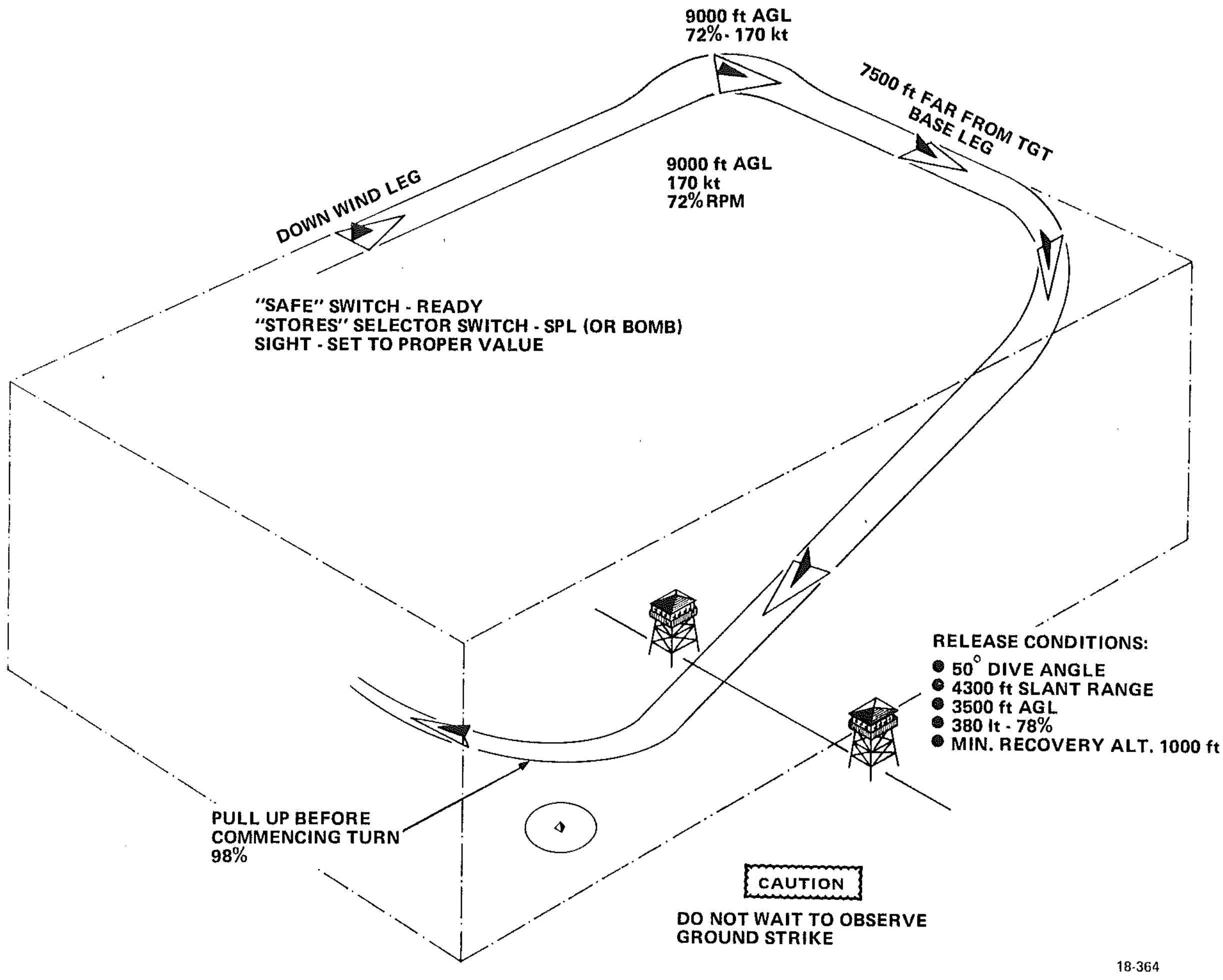


Figure 4-54.

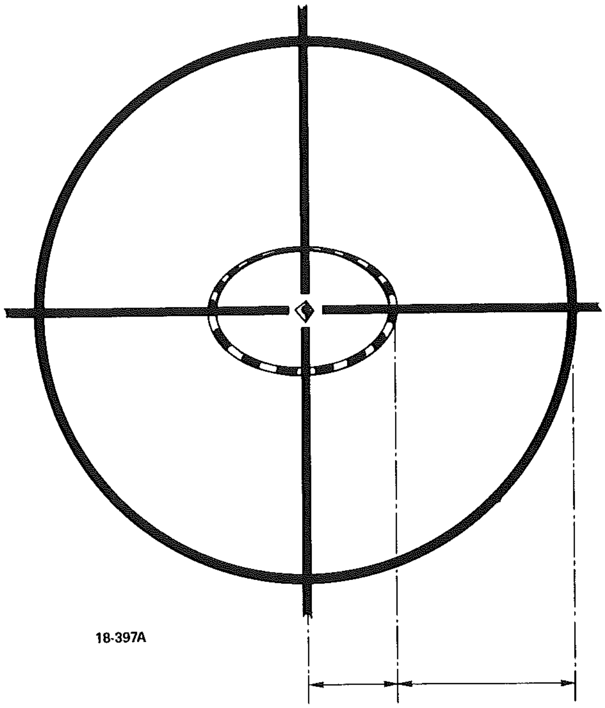
proper position. When the base leg is in the proper position you should be able to look over the side of the cockpit and see the target on the ground. As you approach the turn to final, check the color of the ground control panel and make your radio call. You will have to reduce power to maintain 170 kt on base leg and should have the power back to 88 percent when turning on the final approach, to prevent excessive diving speed. As you start your turn onto final, check the range control panel and make your radio call. This turn should be executed as a wing over type turn, pulling the nose of the aircraft down to the target. Because of the depressed sight this places the pipper well below the target and prevents the necessity of pushover to obtain the desired sight picture after aligning with the target on the final approach.

As the slant range decreases, you should fly the pipper up to the target. The pipper movement should be such that it arrives on the bulls-eye just prior to reaching the desired slant range and altitude.

The "pendulum effect" of the depressed sight will probably cause you to overcorrect, until you have learned how much turn will give you the amount of correction you desire.

Once you have made your correction and the "pipper"is tracking smoothly along the ground toward the target, check the reticle size as compared with 150-foot circle of the target on the ground. When the reticle superimposed on the major axis of the 150-foot circle, as shown in fig. 4-55, your slant range is 4150 ft. At this point, with the pipper on this bulls-eye, depress the bomb release button, and begin your pull-out.

HIGH ANGLE BOMBING SIGHT PICTURE



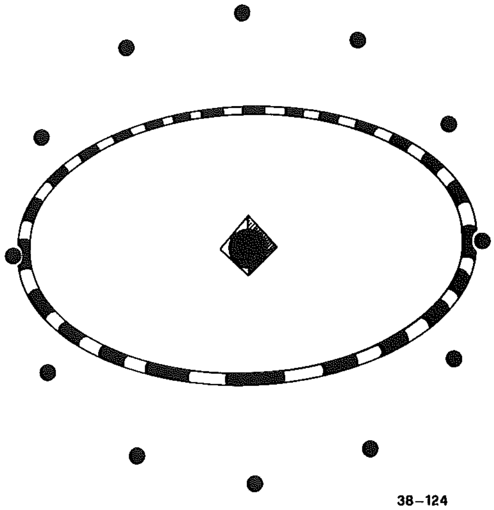
AERITALIA 8-105-924 GUNSIGHT ([B] AIRCRAFT)

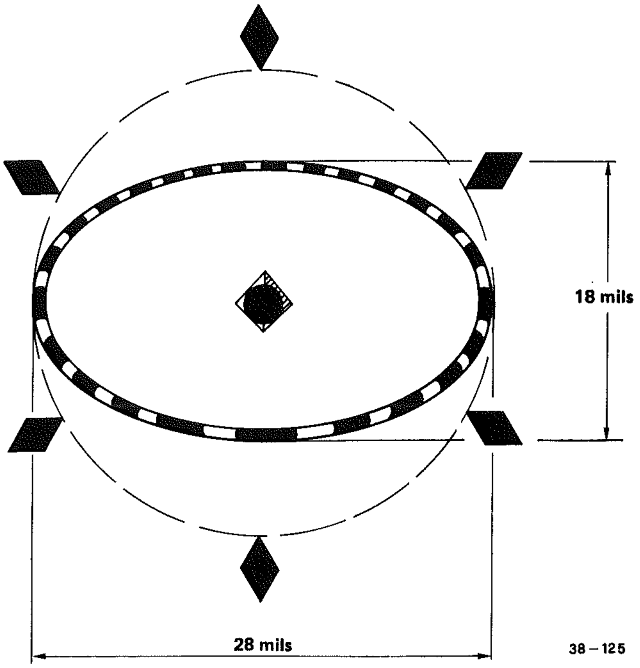
AT 4150 ft SLANT RANGE AND 40° DIVE ANGLE THE SIGHT CIRCLE APPEARS TO BE 3 TIMES (IN DIAMETER) LARGER THAN THE TARGET CIRCLE MAJOR AXIS AND 4 TIMES LARGER THAN THE MINOR AXIS OF THE TARGET CIRCLE.

THOMSON R322Z(M) GUNSIGHT ([A] AIRCRAFT)

- SET TARGET SPAN DRUM TO 30 ft.
- SET RANGE DRUM TO READ ON THE SIGHTING HEAD A NOMINAL RANGE OF 277 yd.

AT 4150 ft SLANT RANGE AND 40° DIVE ANGLE THE DIAMOND INSCRIBING THE CIRCLE IS COINCIDENT WITH THE TARGET MAJOR AXIS.





THOMSON-CSF RD21 GUNSIGHT ([B] AIRCRAFT)

AT 4150 ft SLANT RANGE AND 40° DIVE ANGLE THE DOTTED CIRCLE OF THE SIGHT APPEARS TO BE SUPERIMPOSED TO THE TARGET MAJOR AXIS.

Figure 4-55.

With a 4150-foot release slant range, a 4 to 5 "g" pull-out will allow you to complete your recovery above the minimum altitude of 1000 ft. When the nose of the aircraft is well above the horizon, apply full power and start your turn to be downwind leg. Effect of varying the bomb release conditions are as follows:

a. OVERSPEED

Overshoots the target.

b. UNDERSPEED

Undershoots the target.

c. RELEASE OUT OF RANGE

Undershoots the target.

d. RELEASE IN TOO CLOSE

Overshoots the target.

e. DIVE ANGLE OVER 40 DEGREES

Overshoots the target.

f. DIVE ANGLE UNDER 40 DEGREES

Undershoots the target.

g. POSITIVE "g" DURING RELEASE

Undershoots the target.

h. NEGATIVE "g" DURING RELEASE

Overshoots the target.

i. SKID DURING RELEASE

Line error in the direction of the ball.

The Range Officer will call each bomb hit as soon as it is plotted. He will call it in footage from the bull's-eye in the clock position and you will acknowledge each transmission. As you climb back to the base leg you should analyze the pass, determine the errors made, and make necessary corrections. Your dive angle is controlled by your base leg position, and altitude, as these factors are very important in setting up your attack. Your airspeed is controlled by your power setting and after the first pass, using the approximate setting given, you should know just how much power is necessary to obtain 380 kt in the aircraft you are flying. Slant range at release point is controlled by sight picture, if you have the proper sight picture when you release, you will be releasing at 4150 ft slant range. Good trim technique and good tracking before release, will eliminate the necessity of holding positive of negative "g" at the release point.

The Range Officer will notify the flight of wind condition on the range. Wind correction the bombing is two (2) mils per knot of crosswind. You should adjust your aiming into the wind by moving the aiming point around the target into the crosswind, and keeping it the same distance out from the bulls-eye. You will note that this bombing system more nearly simulates conditions you will have in combat. You no longer need a 150-foot circle to estimate slant range, and the only advance information you need is the target elevation. Simple computations for dive angle, aiming point altitude and sight setting can be made prior to the combat mission.

SECTION V

PLANNING PROCEDURES AND SAMPLE PROBLEMS

TABLE OF CONTENTS

Title	Page
Introduction	5-1
Description of Section VI Charts and Tables	5-2
Bombs and Rockets Charts and Tables	5-6
Sample Problems	5-8

INTRODUCTION

The purpose of this section is to provide the aircrew with the data required to plan a weapon delivery mission with any certified stores and illustrates the planning procedure.

The ballistics tables are based on the ICAO standard day conditions. Ambient pressure and temperature variations from the standard day are considered to have negligible effect on trajectory accuracy. This assumption is valid for most conventional weapon delivery conditions because the weapon time of flight is generally small.

REFERENCE LINES

The various reference lines used in this manual are illustrated in figure 5-1. Other possible identifications of a particular reference line are also stated.

A. Zero Sight Line (ZSL): 26 mils above FRL

B. Fuselage Reference Line (FRL)

C. Flight Path

D. Depressed Sight Line

E. Pylon Reference Line: (FRL - 26 mils above FRL)

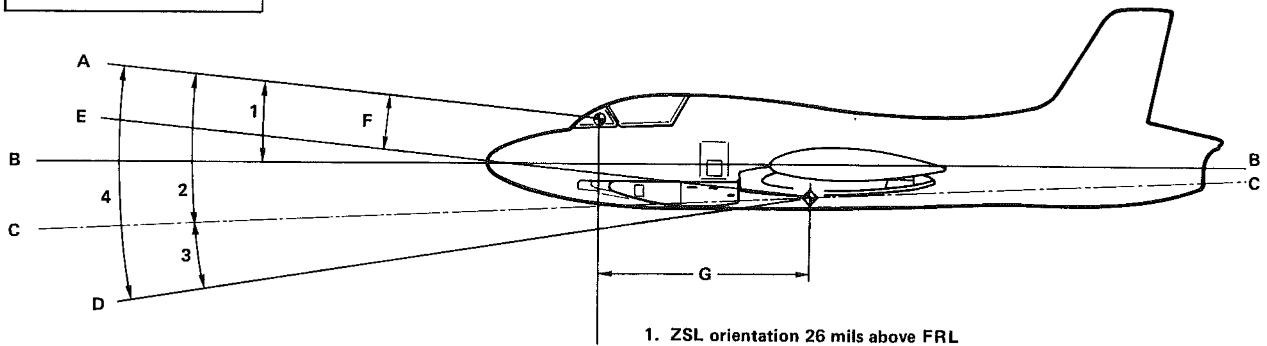
F. Vertical Parallax: 4 ft

G. Horizontal Parallax: 11 ft

PRESSURE ALTITUDE

Pressure altitude is the altitude measured from standard sea level pressure, 29.92 in. of mercury (Hg). Pressure altitude is also

REFERENCE LINES



1. ZSL orientation 26 mils above FRL
2. ZSL angle of attack
3. Depression from flight path (from bombing tables)
4. Actual sight setting

Figure 5-1.

the altitude read on the altimeter when set on 29.92 in. Hg. Target pressure altitude, used in mission plannings, will be obtained from the weather forecaster or based on the prevailing pressure altitude.

NOTE

> If release pressure altitude is not known, release altitude MSL may be used (i.e. release altitude AGL, plus target elevation MSL).

Target pressure altitude can be computed, if the altimeter settings for the target area are known, by substracting 29.92 from the altimeter setting and applying the standard lapse rate (0.01 in. Hg. = 10 ft) to the pressure difference. If the altimeter setting is higher than 29.92 substract the altitude difference from target elevations (MSL). If the reported altimeter setting is lower than 29.92, add the altitude difference to the target elevation (MSL).

Example

Altimeter setting (-H, +L):	-30.62 in. Hg.
Standard datum plane:	29.92 in. Hg.
Pressure difference:	-0.70 in. Hg.

Lapse rate (100 ft/0.10 in) = 700 ft

Release altitude (MSL)	4000 ft
Altitude difference:	-700 ft
Release pressure altitude:	3300 ft

SIGHT SETTING COMPUTATION

The bombing tables provide the sight depression angle from flight path. Use the angle of attack chart to find the aircraft angle of attack in mils. Angle of attack, plus sight depression angle from flight path, equals the optical sight setting for zero wind.

Wind correction can be applied to the sight setting or wind correction can be made by estimating an upwind aimpoint. The tables provide the data required for both methods of wind correction. The mil correction is added for headwind and substracted for tailwind.

INTERPOLATION OF BALLISTIC TABLES (See Volume 2)

When it is deemed necessary to interpolate the ballistic tables, the following review may be helpful. Assume that the sight depression is to be interpolated for 315 KTAS:

$$\begin{array}{r} 300 \text{ kt} = 45.4 \text{ mils} \\ 320 \text{ kt} = \underline{41.0 \text{ mils}} \\ 4.4 \text{ mils} \end{array}$$

$$\frac{(320 \text{ kt}) - (315 \text{ kt})}{(320 \text{ kt}) - (300 \text{ kt})} \times 4.4 \text{ mils}$$

$$\frac{5}{20} \times 4.4 = 1.1 \text{ mils}$$

$$1.1 + 11.0 = 12.1 \text{ mils}$$

$$315 \text{ kt} = 42.1 \text{ mils}$$

DESCRIPTION OF SECTION VI CHARTS AND TABLES

MISSION PLANNING FORM

The mission planning form (figure 6-1) provides a sequence for planning a weapon delivery mission.

The planning form is divided into five parts. The first three parts (Mission Conditions, Release Conditions, and Wind Values) are applicable to all delivery modes. The remaining two parts (Dive and Level Bombing Conditions, and Rocket Launch and Strafing Conditions) are applicable only to the delivery mode implied.

DIVE RECOVERY CHARTS

The dive recovery charts (figure 6-2) are used to determine the altitude lost during pullout after bomb release. Three charts are provided. The charts are based on an acceleration of 3.0 g, 3.5 g, or 4.0 g obtained in two seconds after release. No throttle advance was assumed until the nose of the aircraft passed through the horizon. Enter the charts with release velocity TAS, project to the dive angle and down to read altitude lost. Release altitudes must be greater than the sum of altitude lost during pullout and minimum recovery altitude above ground. These charts contain no reaction time and no safety factors.

ZERO SIGHT LINE ANGLE OF ATTACK TABLE

The angle of attack table (figure 6-3) is used to determine the aircraft angle of attack. The purpose of the table is to aid in computing optical sight depression angle in mils.

NOTE

> The unit of measurement used to calibrate the mil scale is: 1 degree = 17.45 mils, or 1 mil = 0.0573 degree.

Enter the table with the release indicated airspeed, the aircraft gross mass at release, project to preplanned dive angle, and read the aircraft angle of attack in mils. To determine the optical sight setting for zero wind conditions, add this angle of attack value to the sight depression from flight path obtained from the sight depression charts (figure 6-3) or the bombing tables.

HORIZONTAL RANGE CHART

The horizontal range charts (figure 6-4) provide the horizontal distance from release to impact for a given release altitude AGL and for a given depression angle. Eleven charts are provided to accomodate the following dive angles: level flight thru 50° dive in 5° increments. Enter the proper dive angle chart with desired right depression. Move right to release altitude across to depression angle from flight path. Parallax correction factors are included in these charts.

AIRSPEED CONVERSION CHART

The airspeed conversion chart (figure 6-5) may be used to convert indicated airspeed (IAS) to true mach number, to true airspeed (TAS) and/or vice-versa. Release pressure altitude and free-air temperature (°C) are required for the use of this chart. Enter the chart with release velocity CAS. Project up to release pressure altitude, across to true mach number and to release temperature, and then to KTAS. Reverse this procedure for KTAS to KIAS conversion.

ALTIMETER CORRECTION CHART

The altimeter correction chart (figure 6-6) may be used to correct the altimeter reading for position or installation error. The error is a function of release pressure altitude and indicated airspeed.
Enter the chart with release indicated airspeed (KIAS), project up to release pressure altitude and across to the altitude error correction.

ALTIMETER LAG CHART

During a dive, the altimeter does not unwind at a rate equal to the actual rate of aircraft descent. The altimeter lag chart (figure 6-7) provides the altitude that should be added to obtain an indicated release altitude above ground level. Enter the chart with release velocity TAS, project to the dive angle, and down to read altimeter lag.

RELEASE INDICATED ALTITUDES

Release indicated altitude is the sum of the following items:

a. Release altitude above MSL.

b. Release altitude above target.

c. Altimeter lag.

d. Altimeter position error correction.

RELATIVE WIND VECTOR CHART

When forecast wind data is used for mission planning, the relative wind vector chart (figure 6-8) is used to obtain the rangewind and crosswind components. The wind velocity at release altitude should be used. The displacement of the bomb is a function of initial velocity and time of flight.
As the time becomes less, the magnitude of deflection is also less. Use the relative wind vector chart as follows:

Given

a. Forecast wind: 350°/30 kt

b. Approach course to target: 040 degrees

Find

a. Relative wind direction: 310 degrees

b. Rangewind component: 20 kt headwind

c. Crosswind component: 23 kt left

NOTE

> If the aircraft course to target is greater than the wind direction, add 360 degrees to the wind direction; then substract aircraft course from the wind direction to obtain relative wind direction.

Relative wind direction must be determined before entering the relative wind vector chart. Obtain relative wind direction by substracting approach course to target, 040 degrees from forecast wind direction over target.

350° - 40° = 310° relative wind direction.

Enter the relative wind vector chart (figure 6-8) with 310 degrees. Project to the 30-knot wind circle and over to the horizontal and the vertical axes: read the rangewind and crosswind components respectively.

WIND CORRECTION

Offset Aimpoint

For level delivery of the high drag bombs, crosswind correction is usually achieved by crabbing the aircraft into the wind and offsetting the ground track in the upwind direction parallel to the no-wind course. Rangewind correction is accomplished by correcting the sight setting or by releasing early or late. The equation for rangewind is as follows:

(Range wind in knots) x (tc) x (1.69) = = correction in feet

When the aircraft is crabbed to maintain a ground track during the approach and release, the need for crosswind correction is reduced, as illustrated by the following equation which is valid for both high drag and low drag bombs.

(Crosswind in knots) x (tc) x (1.69) - - (R_c/V_A) = correction in feet.

Where

t_c = Bomb time of fall in seconds.

R_c = Bomb range in feet

V_A = Release velocity in knots TAS

1.69 = Conversion factor to change knots to feet per second.

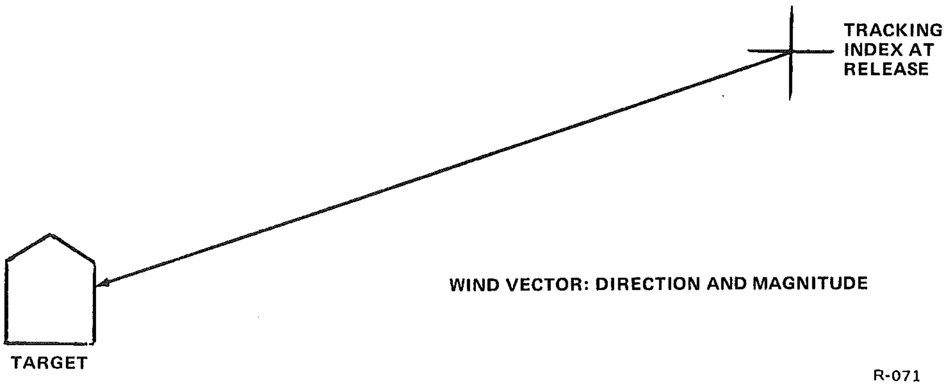
For the low-altitude level delivery of the lowdrag bombs, crosswind correction is usually achieved by crabbing the aircraft into the wind so that the aircraft ground track will pass through the target. The equation will show that an offset ground track is not required.

When the crabbing technique is used with a sight that is not drift stabilized, the pipper will not be directly on the target when release occurs; because of the crab angle, there will be an apparent increase in the sight angle. As the crab angle increases, the pipper described an imaginary arc through the target radiating from the release point. Therefore, the bomb should be released when the pipper is on the arc which will appear to be short of the target.

Upwind Aimpoint

The upwind aimpoint method of wind correction can be used for all delivery modes and all weapons. The total wind speed at release

SINGLE OFFSET AIMPOINT


TRACKING INDEX AT RELEASE
WIND VECTOR: DIRECTION AND MAGNITUDE
TARGET
R-071

NOTE

Gunsight cross is positioned the same at release regardless of the attack heading.

Figure 5-2

altitude is used to relocate the aimpoint upwind from the target by an amount equal to the product of the total wind speed by the weapon time to fall. The upwind aimpoint may be approached from any direction. The no-wind sight is used and the weapon is released at the planned release conditions. The aircraft is drifting i.e., no attempt is made to correct the aircraft for drift by crabbing.

FUZE ARMING TABLES

Fuze Arming and Safe Escape

Fuze arming is the vertical distance below the release point where the fuze will be unarmed. If the bomb impact occurs within the fuze arming distance, a dud bomb is predicted.

WARNING

> The lower release conditions provided in the ballistics tables in Volume 2 and in the check-list should be checked with the Fuze Arming and Safe Escape tables to ensure a safe delivery condition:
>
> a. Fuze Arming, figure 6-16.
>
> b. Safe Escape, figure 6-17.

For the M904 and M905 fuzes, only the four and six-second arming delay settings are considered. Current tolerances listed for the arming delay times are ± 20 percent of the delay settings. The delay setting plus the positive tolerance was used in the determination of minimum release altitudes, or vertical drop required for these fuzes to arm. For example, the four-second arming delay setting will require a minimum bomb time fall of 4.8 s. The six-second arming delay setting requires a minimum time fall of 7.2 s.

The minimum release altitudes for the level release of GP bombs are provided in the safe escape table for a 4.0 g power pullout at release and for straight and level, constant speed recovery. The minimum launch altitudes for the 2.75-inch rocket with H.E. and M151 warhead are provided for various dive angles and airspeeds.

Fuze Safe Arming Times

The objective of the following discussion is two-fold:

a. Point out the wide variation in required safe escape distances and safe fuze arming times for the various release conditions, release modes, and escape maneuvers.

b. Emphasize the importance of a judicious selection of fuze safe arming times during mission planning where VT or impact fuzes are involved. The fuze arming times, which are required to assure safe escape from premature airbursts (or earlier-than-intended impact bursts), vary widely as a function of release conditions (level or dive, low altitude or high altitude) and release modes (single, pairs, salvo, or timed ripple). The required safe arming times provided in figure (see sample figures) for various GP bombs are listed as a function of release conditions and escape maneuvers. For clarity, an illustration of the delivery and escape maneuver profile for each type of release and escape maneuver is also presented.

VT Fuze Munitions. When using proximity fuzes with GP bombs, safety considerations require that the fuzes be kept unarmed until the releasing aircraft has attained an adequate distance from the munition to assure safe escape.

WARNING

> Observance of this safety consideration is absolutely mandatory to assure that the delivery aircraft will not be hit by lethal fragments from its own munition in the event of a premature detonation at the expiration of the fuze arming time.

In the determination of the VT fuze safe arming time setting, the value selected should be equal to or greater than the required safe arming time value shown in the table for the desired release condition, release mode, and escape maneuver.

Impact Fuzed Munitions. Ordinarily, premature airburst detonation of impact fuzed munitions are not anticipated. However, to protect the aircraft and aircrew from any earlier-than-intended burst, fuze safe arming time settings, which will assure safe escape, should be employed with impact type fuzes (as well as VT fuzes) whenever operational considerations will permit this course of action. Use of this procedure would help protect the aricraft and aircrew in the event of an inadvertent low altitude release as well as any premature airburst.

WARNING

- o If operational considerations and the range of available fuze arming time settings require the selection of settings which will not assure safe escape from an earlier-than-intended burst, the aircrew should be briefed to carefully observe the appropriate minimum release altitudes and recovery maneuvers required for safe escape.
- o As an additional safety precaution, whenever operational considerations require the use of fuze arming time settings which will not assure safe escape from a premature burst, the aircrew should be briefed to execute a pullup or banked turn escape maneuver immediately after release. (The extent of this maneuver will be dictated by current flight limitations).

DETERMINATION OF MINIMUM ACCEPTABLE RELEASE ALTITUDE

The vertical drop of fuze arming, minimum recovery altitude, and bomb fragmentation envelope clearance must all be considered in the determination of the minimum acceptable release conditions. The altitude or vertical drop required for each of these parameters should be determined from the data listed in the safe escape and fuze arming tables. The greatest value is the minimum release altitudes for the fuzes dive angles, and airspeed conditions being considered. For example, assume that the M117, M117A1 bomb with the M904 nose fuze with a 6.0 s setting is to be released from 360 KTAS in a 40° dive. For the release condition, the M904 nose fuze requires a vertical drop of 3585 ft for the fuze to arm. The minimum release altitude required for the fragment envelope clearance is 2200 ft. In this case, the minimum release altitude is governed by the time required for the M904 nose fuze to arm. The minimum acceptable release altitudes for the other compatible fuzes determined in a similar manner.

CAUTION

The aircrew must determine the minimum ground clearance.

BOMBS AND ROCKETS CHARTS AND TABLES (see Volume 2)

LEVEL AND DIVE BOMBING TABLES (GP BOMBS)

The release conditions, contained in the dive bombing tables, provide at least a 100-foot ground clearance. The ground clearance computations were based on a pullout acceleration of 4.0 g obtained in two seconds after release. Level and dive bombing ballistic tables are provided for the following munitions in Volume 2.

a. MK81 Low Drag GP Bomb.

b. MK82 Low Drag GP Bomb.

c. AN-M64A1, 500 lb, GP Bomb.

d. AN-M57A1, 250 lb, GP Bomb.

e. AEREA 559G1 Fire Bombs.

f. BDU-33/B or MK 76 Practice Bomb with Aermacchi adapter.

g. BDU-33A/B and BDU-33B/B Practice Bomb with Aermacchi adapter.

Other bomb types were divided into three classes depending upon their ballistic coefficient. Twenty graphs are provided to calculate sight settings for level and dive release of the Class A; B and C bombs in Volume 2.

BOMB RELEASE CONDITIONS

The bombing tables include the following parameters:

a. Release true airspeed: 240 kt thru 400 kt in 20-knot increments.

b. Dive angles: MK82 LDGP, MK81 LDGP, Aerea 559G1, M57A1, BDU-33/B, BDU--33A/B and BDU-33B/B Practice Bombs at 0° and 15° thru 50°, in 5° increments.

The following data are obtained from the bombing tables:

a. Release altitude above target, in feet.

b. Bomb horizontal range from release to impact, in feet.

c. Bomb time of flight, in seconds.

d. Slant range from release to impact, in feet.

e. Bomb impact angle, in degrees.

f. Sight depression from flight path, in mils (Zero sight line angle of attack must be added to obtain the optical sight depression).

g. Wind correction factors: headwind and tailwind in mils per knot of wind; and crosswind for drifting aircraft and/or for a crabbing aircraft (level release) in feet per knot of wind. Refer to wind correction for a description of wind factor application.

LOW LEVEL AND GLIDE BOMBING TABLES (FIRE BOMBS)

The low level and glide bombing tables are provided for the fire bombs. The fire and practice bomb tables have been computed to provide a sight depression angle that will place bomb impact on target; 3.9 ft was added to compensate for the distance between the bomb rack and the sight head. Low level and glide bombing tables are provided for the AEREA 559G1 Fire Bomb.

Release Conditions

The low level and glide bombing tables include the following parameters:

a. Release true airspeed: 220 kt thru 400 kt in 20-knot increments.

b. Dive angles: 0° thru 45° in 5° increments.

The data obtained from the bombing tables are the same as obtained from the dive bombing tables for the GP Bombs.

CAUTION

> Fire bomb tables data are estimated and not tested in flight.

FLARE DISPENSING - MK24 FLARE

The low level release tables are computed for the MK24 aircraft parachute flare. A sample problem is not provided for this delivery mode. The flare dispensing table provides the minimum release altitudes AGL that will ensure flare burnout at ground level. The table also provides the horizontal distance travelled and vertical drop of the flare prior to ignition.

ROCKET LAUNCH AND GUN FIRING TABLES

Rocket launch tables are provided for folding fin aircraft rocket (FFAR) launched form any rocket launchers loaded on the aircraft; as well as for:

- 68 mm SNEB FFAR type F1
- 50 mm SNIA FFAR
- 5 in. FFAR ZUNI
- 2.75 in. FFAR

Gun firing tables are applicable for the SUU-11B/A gun pod and cal .50 machine gun in Aermacchi gun pod.

The gun tables were computed with the assumption that the guns would be harmonized 26 mils above FRL, that means parallel to ZSL.

Tables do not correct for any gun bias values that may relate to any particular system.

The rocket launch and gun firing tables provide the time of flight, optical sight setting, slant, slant range, horizontal range, and wind correction factors as a function of the following parameters:

1. Aircraft gross mass.
2. Launch of firing altitude above target.
3. Launch or firing indicated airspeed.
4. Dive angle.

For aircraft gross mass not included in the tables, a linear interpolation can be used to obtain optical sight setting, slant range, and horizontal range values. The optical sight setting values provided in these tables are the actucal sight settings for zero wind and include the angle-of-attack correction, the parallax correction and windshield refraction correction.

The wind correction factors provide wind effect in feet per knot, which can be used to establish an upwind aimpoint and in mils per knot, which can be used to correct the sight setting for rangewind (add the mil correction for headwind, substract the mil correction for tailwind). When the wind effect in feet is used to correct for rangewind, substract the wind effect distance from the horizontal range for headwind or offset the aimpoint beyond the target. Reverse the process for tailwind. For crosswind, the aircraft flight path should be offset in the upwind direction to a distance equal to the wind effect distance.

SAMPLE PROBLEMS

DIVE AND LOW LEVEL BOMBING SAMPLE PROBLEM

Mission Condition

The following sample problem uses 40 degrees dive release conditions for AN-M64A1 GP Bomb using the M904E1 nose fuze with a 4.0 s arming delay setting, and will follow the order as outlined in the mission planning from (figure 5-3). A release indicated airspeed of 360 kt, a relase altitude of 3000 ft AGL, and a target height of 1000 ft MSL are assumed. Item 4 of the mission planning form is the total weight of the external stores carried. Compute the fuel remaining over the target (item 6). Add this value to the sum of aircraft operating mass (item 5) and external mass (item 4) to obtain gross mass over the target (item 7).
The aircraft operating mass (item 5) does not include the weight of the pylons.
Obtain the following data from the weather forecaster:

a. Altimeter setting at target (item 9): 28.94 in.Hg

b. Release pressure altitude (item 14): 4000 ft.

c. Release altitude temperature (item 15): 16°C.

d. Wind velocity (item 22); 350 degrees true/30 kt.

Release Conditions

The following charts are used to determine item 16, 17, 18, 19, 20, 21 and to verify that the planned release altitude of 3000 ft AGL is sufficently high to provide adequate time for fuze arming ground clearance, during recovery, and fragment envelope clearance.

a. KIAS - KTAS Chart, figure 6-5.

b. Dive Recovery Chart, figure 6-2.

c. Altimeter Correction Chart, figure 6-6.

d. Angle of Attack Chart, figure 6-3.

e. Safe Escape Chart, figure 6-10.

The release KIAS (item 11) 360 kt, dive angle (item 12) 40 degrees, release altitude above ground (item 13) 3000 ft, release pressure altitude (item 14) 4000 ft, and release altitude temperature (item 15) 16°C, are recoreded in the planning form. Use the KIAS to KTAS conversion chart (figure 6-5) to determine release KTAS (item 16) 382 kt. Use the dive recovery chart pullout acceleration of 4 g (figure 6-2) to determine altitude lost during pullout (item 17) 1500 ft. Use the altimeter correction chart (figure 6-6) to determine altimeter correction (item 18) + 80 ft. Use the altimeter lag chart (figure 6-7) to determine altimeter lag (item 19) 152 feet.
Release indicated altitude (item 20) is the sum of the following items:

-	Item 8, Target Altitude above MSL	1000 ft
-	Item 13, Release Altitude above Ground	3000 ft
-	Item 18, Altimeter Correction	+ 80 ft
-	Item 19, Altimeter Lag	152 ft
-	Release Indicated Altitude	4232 ft

Use the zero sight line angle of attack chart (figure 6-3) to find the zero line angle of attack (item 21), and the relative wind vector chart (figure 6-8) to determine the release altitude rangewind and crosswind components (Items 24 and 25).

Dive and Level Bombing Conditions

Select the proper bombing table (Volume 2) for the planned 40 degree dive, 3000 ft AGL, 383 KTAS release condition and record bomb time of fall, bomb range, sight depression angle from flight path, and wind correction factors in the planning form.

a. Item 26, Bomb Time of Flight: 6.02 s.

b. Item 27, Bomb Range: 2891 ft.

c. Item 30, Sight Depression from Flight Path: 110 mils;

d. Item 31, Headwind Correction Factor: 1.83 mil/kt.

e. Item 32, Tailwind Correction Factor: Nil mils/kt.

f. Item 33, Crosswind Correction Factor: 10.2 ft/kt.

Rangewind Correction

Multiply the headwind tail wind correction factor (item 31/32) by the rangewind component (19 kt headwind) (item 24) to obtain the rangewind correction to sight depression angle (item 34).

1.83 X 19 = 35 mils

Sight Setting

Add sight depression angle from flight path (item 30), rangewind correction factor (item 34), zero sight line angle of attack (item 21) and windshield refraction (item 36) using fig. 6-14.

110 + 35 + 3 + 7 = 155 mils

Offset Aimpoint

Multiply the crosswind correction factor (item 33), by the release crosswind component (item 25) to obtain the crosswind correction (item 35).

15.7 X 23 = 360 ft

For level releases, two columns of crosswind correction factors are listed. If the aircraft is assumed to be drifting with the wind, use the crosswind correction factor listed under drift. If a crab angle is used to maintain a ground track through the target, use the crosswind correction factor listed under crab. For low drag items, released at low altitudes, use of a crab angle to maintain a ground track through the target will eliminate the need for the offset aimpoint. To compute the single offset aimpoint for dive bombing, accomplish the following steps:

a. Obtain the winds at the desired levels and compute an average wind.

b. Determine the total wind correction by multiplying the wind velocity by the crosswind (feet/knot) factor obtained from the appropriate ballistics table (item 33).

c. Offset directly into the wind from the target.

d. Release the ordnance with the tracking index on the computed aimpoint from any direction of attack (see figure 5-2).

ROCKET FIRING SAMPLE PROBLEM

Computational procedures for rocket firing are very similar to the procedures used in the planning of a bombing mission. Due to the similarity of bombing and rocket computational procedures, a completed mission planning form (figure 5-4) for FFAR mission is provided to illustrate the rocket planning procedures.

Sample 1

MISSION PLANNING FORM

MISSION CONDITIONS

1. Delivery Mode Dive Bombing

2. Munitions and Unit Mass:

		Munitions	Mass	
a. Outboard		–	–	pounds
b. Intermediate	Bomb	AN-M64A1	590+54*	pounds
c. Inboard	Minigun	SUU-11()/A	324+54*	pounds

* pylon mass

3. Type of Fuzing (IMPACT) (DELAY) (VT)

	Nose	Tail
a. Type:	M904E1	–
b. Action:	Instant	–
c. Functioning Delay:	–	–
d. Arming Delay:	4s	–

4. External Mass:

	No.	Items	Total Mass	
a. Outboard				pounds
b. Intermediate (pylon mass included)	2	644	1288	pounds
c. Inboard (pylon mass included)	2	378	756	pounds
d. Totals			2044	pounds

5. Aircraft Operating Weight . . . . 8329 pounds
6. Fuel Remaining Over Target . . . . 1210 pounds
7. Aircraft Gross Weight Over Target (add items 4d, 5 and 6) . . . . . 11583 pounds
8. Target Altitude above MSL . . . . 1000 feet
9. Altimeter Setting at Target . . . . 28.94 in Hg
10. Approach Course to Target . . . . 040 °True

RELEASE CONDITIONS

11. Release Indicated Airspeed . . . . 360 knots
12. Release Dive Angle . . . . 40 deg
13. Release Altitude above Target . . . . 3000 feet

NOTE

It must be sufficiently high to provide adequate time for fuze arming, ground clearance during recovery, and fragment envelope clearance.

Figure 5-3 (Sheet 1)

MISSION PLANNING FORM (Cont'd)

14. Release Pressure Altitude . . . . 4000 feet
15. Release Altitude Temperature . . . . 16 °C
16. Release True Airspeed . . . . 382 knots
    (From KIAS - KTAS Chart)
17. Altitude Lost During Pullout . . . . 1500 feet
    (From Dive Recovery Chart)
18. Altimeter Correction . . . . +80 feet
    (From Altimeter Correction Chart)
19. Altimeter Lag . . . . 152 feet
    (From Altimeter Lag Chart)
20. Release Indicated Altitude (add items 8, 13, 18 and 19) . . . . 4232 feet
21. Angle of Attack (Zero Sight Line Angle of Attack) . . . . 3 mils

WIND VALUES

22. Forecast Wind . . . . 350 °True 30 knots
23. Relative Wind . . . . 310 °True 30 knots
24. Rangewind Component (head) (tail) . . . . 19 knots
25. Crosswind Component (left) (right) . . . . 23 knots

DIVE AND LEVEL BOMBING CONDITIONS

26. Bomb Time of Flight (*) . . . . 6.02 seconds
27. Bomb Range (Horizontal Range) (*) . . . . 2891 feet
28. Range Correction for Initial Impact (s) . . . . – feet
    (Predetermined distance short of target for CBU or single fire bomb release).
29. Range from Release to Target . . . . 2891 feet
    (Item 27 and 28)
30. Sight Depression from Right Path . . . . 110 mils
    (From tables or charts) (*)
31. Headwind Correction Factor . . . . 1.83 mils/kt
32. Tailwind Correction Factor . . . . – mils/kt
33. Crosswind Correction Factor . . . . 15.7 ft/kt
34. Rangewind Correction to Sight Depression Angle . . . . 35 mils
    (Item 31 or item 32 times item 24)
35. Crosswind Correction . . . . 360 feet
    (Item 33 by item 25)

Figure 5-3. (Sheet 2)

MISSION PLANNING FORM (Cont'd)

36. Windshield Refraction Correction . . . . 7 feet

37. Depressed Sight Setting . . . . 155 mils
(Item 30 plus item 34 plus item 21 plus item 36)

38. Offset Aimpoint (left) (right) . . . . 360 feet
(Item 35)

ROCKET LAUNCH OR STRAFING CONDITIONS

39. Angle of Attack (ZSL) . . . . - mils
(Item 21)

40. Time of Flight (*) . . . . - seconds

41. Release Slant Range (*) . . . . - feet

42. Release Horizontal Range (*) . . . . - feet

43. Sight Depression (no wind) (*) . . . . - mils

44. Rangewind Correction (+ head) (- tail) . . . . - mils

45. Windshield Refraction Correction . . . . - mils

46. Depressed Sight Setting . . . . - mils
(Item 43 plus item 44 plus item 45)

47. Crosswind Correction . . . . - feet

Note (*): From Volume 2

Figure 5-3. (Sheet 3)

MISSION PLANNING FORM

Sample 2

MISSION CONDITIONS

1. Delivery Mode . . Rocket Firing . . . .

2. Munitions and Unit Mass:

	Munition	Mass	
a. Outboard	-	-	pounds
b. Intermediate	LAU-68A	427+54*	pounds
c. Inboard	LAU-68A	427+54*	pounds

*pylon mass

3. Type of Fuzing (IMPACT) (DELAY) (VT)

	Nose	Tail
a. Type:	-	-
b. Action:	-	-
c. Functioning Delay:	-	-
d. Arming Delay:	-	-

4. External Mass:

	No.	Items	Total Mass	
a. Outboard	-	-	-	pounds
b. Intermediate	2	481	962	pounds
c. Inboard	2	481	962	pounds
d. Totals			1924	pounds

5. Aircraft Operating Mass . . . . 8329 pounds

6. Fuel Remaining Over Target . . . . 1210 pounds

7. Aircraft Gross Mass Over Target (add items 4d, 5 and 6) . . . . . . 11463 pounds

8. Target Altitude above MSL . . . . 1000 feet

9. Altimeter Setting at Target . . . . 28.94 in.Hg

10. Approach Course to Target . . . . 040 °True

RELEASE CONDITIONS

11. Release Indicated Airspeed . . . . 340 knots

12. Release Dive Angle . . . . 30 deg

13. Release Altitude above Target (AGL) . . . . 2500 feet

Figure 5-4. (Sheet 1)

MISSION PLANNING FORM (Cont'd)

NOTE

It must be sufficiently high to provide adequate time from fuze arming, ground clearance during recovery, and fragment envelope clearance.

14. Release Pressure Altitude . . . . 3500 feet

15. Release Altitude Temperature . . . . 15 °C

16. Release True Airspeed . . . . 360 knots
    (From KIAS - KTAS Chart)

17. Altitude Lost During Pullout. . . . . 840 feet
    (From Dive Recovery Chart)

18. Altimeter Correction . . . . +110 feet
    (From Altimeter Correction Chart)

19. Altimeter Lag . . . . 134 feet
    (From Altimeter Lag Chart)

20. Release Indicated Altitude (add items 8, 13, 18 and 19) . . . . 3744 feet

21. Angle of Attack (Zero Sight Line Angle of Attack) . . . . 3 mils

WIND VALUE

22. Forecast Wind . . . . 350 °True 30 knots

23. Relative Wind . . . . 310 °True 30 knots

24. Rangewind Component (head) (tail) . . . . 19 knots

25. Crosswind Component (left) (right) . . . . 23 knots

DIVE AND LEVEL BOMBING CONDITIONS

26. Bomb Time of Flight (*). . . . . – seconds

27. Bomb Range (Horizontal Range) (*) . . . . – feet

28. Range Correction for Initial Impact (s) . . . . – feet
    (Predetermined distance short of target for CBU or single fire bomb release)

29. Range from Release to Target . . . . – feet
    (Item 27 and 28)

30. Sight Depression from Right Path . . . . – mils
    (From tables or charts) (*)

31. Headwind Correction Factor . . . . – mils/kt

32. Tailwind Correction Factor . . . . – mils/kt

33. Crosswind Correction Factor. . . . . – ft/kt

34. Rangewind Correction to Sight Depression Angle. . . . . – mils
    (Item 31 or item 32 by item 24)

Figure 5-4. (Sheet 2)

MISSION PLANNING FORM (Cont'd)

35. Crosswind Correction (Item 33 by item 25)	–	feet
36. Windshield Refraction Correction	–	mils
37. Depressed Sight Setting (Item 30 plus item 34 plus item 21 plus item 36)	–	mils
38. Offset Aimpoint (left) (right) (Item 35)	–	feet

ROCKET LAUNCH OR STRAFING CONDITIONS

39. Angle of Attack (ZSL) (Item 21)	3	mils
40. Time of Flight (*)	2.62	seconds
41. Release Slant	4722	feet
42. Release Horizontal Range (*)	4010	feet
43. Sight Depression (no wind) (*)	31	mils
44. Rangewind Correction (+ head) (- tail)	+15	mils
45. Windshield Refraction Correction	1	mils
46. Depressed Sight Setting (Item 43 plus item 44 plus item 45)	47	mils
47. Crosswind Correction	100	feet

Note (*): From Volume 2

Figure 5-4. (Sheet 3)

SECTION VI

PLANNING CHARTS AND TABLES

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MISSION PLANNING FORM

MISSION CONDITIONS

1. Delivery Mode . . . .

2. Munitions and Unit Mass:

	Munition	Mass	
a. Outboard	______	______	pounds
b. Intermediate	______	______	pounds
c. Inboard	______	______	pounds

3. Type of Fuzing (IMPACT) (DELAY) (VT)

	Nose	Tail
a. Type:	______	______
b. Action:	______	______
c. Functioning Delay:	______	______
d. Arming Delay:	______	______

4. External Mass:

	No.	Items	Total Mass	
a. Outboard	______	______	______	pounds
b. Intermediate (pylon mass included)	______	______	______	pounds
c. Inboard (pylon mass included)	______	______	______	pounds
d. Totals	______	______	______	pounds

5. Aircraft Operating Mass . . . . ______ pounds

6. Fuel Remaining Over Target . . . . ______ pounds

7. Aircraft Gross Mass Over Target (add items 4a, 5 and 6) . . . . . ______ pounds

8. Target Altitude above MSL . . . . ______ feet

9. Altimeter Setting at Target . . . . ______ in.Hg

10. Approach Course to Target . . . . ______ °True

RELEASE CONDITIONS

11. Release Indicated Airspeed . . . . ______ knots

12. Release Dive Angle . . . . ______ deg

13. Release Altitude above Target (AGL) . . . . ______ feet

NOTE

It must be sufficiently high to provide adequate time for fuze arming, ground clearance during recovery, and fragment envelope clearance.

Figure 6-1. (Sheet 1)

MISSION PLANNING FORM (Cont'd)

14. Release Pressure Altitude . . . . _______ feet

15. Release Altitude Temperature . . . . _______ °C

16. Release Tue Airspeed . . . . _______ knots
(From KIAS - KTAS Chart)

17. Altitude Lost During Pullout . . . . _______ feet
(From Dive Recovery Chart)

18. Altimeter Correction . . . . _______ feet
(From Altimeter Correction Chart)

19. Altimeter Lag . . . . _______ feet
(From Altimeter Lag Chart)

20. Release Indicated Altitude (add items 8, 13, 18 and 19) . . . . _______ feet

21. Angle of Attack (Zero Sight Line Angle of Attack) . . . . _______ mils

WIND VALUES

22. Forecast Wind . . . . _______ °True _______ knots

23. Relative Wind . . . . _______ °True _______ knots

24. Rangewind Component (head) (tail) . . . . _______ knots

25. Crosswind Components (left) (tail) . . . . _______ knots

DIVE AND LEVEL BOMBING CONDITIONS

26. Bomb Time of Flight (*) . . . . _______ seconds

27. Bomb Range (Horizontal Range) (*) . . . . _______ feet

28. Range Correction for Initial Impact(*) . . . . _______ feet
(Predetermined distance short of target for CBU or single fire bomb release).

29. Range from Release to Target . . . . _______ feet
(Items 27 and 28)

30. Sight Depression from Right Path . . . . _______ mils
(From tables or charts) (*)

31. Headwind Correction Factor . . . . _______ mils/kt

32. Tailwind Correction Factor . . . . _______ mils/kt

33. Crosswind Correction Factor . . . . _______ ft/kt

34 Rangewind Correction to Sight Depression Angle . . . . _______ mils
(Item 31 or item 32 times item 24)

35. Crosswind Correction . . . . _______ feet
(Item 33 times item 25)

Figure 6-1. (Sheet 2)

MISSION PLANNING FORM (Cont'd)

36. Windshield Refraction Correction . . . . ________ mils

37. Depressed Sight Setting . . . . ________ mils
(Item 30 plus item 34 plus item 21 plus item 36)

38. Offset Aimpoint (left) (right) . . . . ________ feet
(Item 35)

ROCKET LAUNCH OR STRAFING CONDITIONS

39. Angle of Attack (ZSL) . . . . ________ mils
(Item 21)

40. Time of Flight (*) . . . . ________ seconds

41. Release Slant Range (*) . . . . ________ feet

42. Release Horizontal Range (*) . . . . ________ feet

43. Sight Depression (no wind) (*) . . . . ________ mils

44. Rangewind Correction (+ head) (- tail) . . . . ________ mils

45. Windshield Refraction Correction . . . . ________ mils

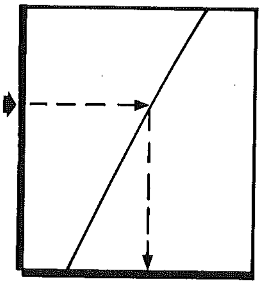
46. Depressed Sight Setting . . . . ________ mils
(Item 43 plus item 44 plus item 45)

47. Crosswind Correction . . . . ________ feet

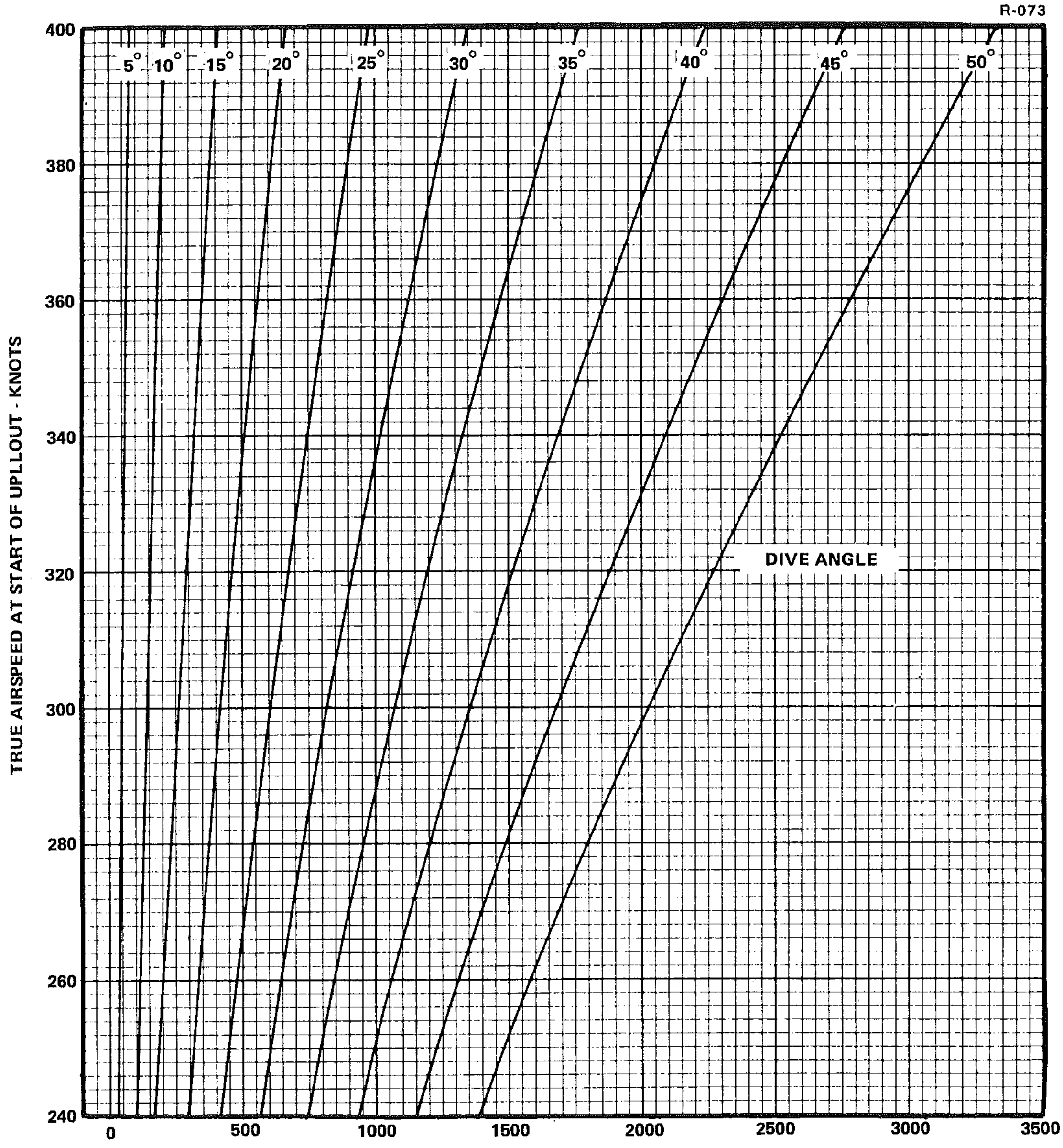
Note (*): From Volume 2

Figure 6-1. (Sheet 3)

DIVE RECOVERY CHART



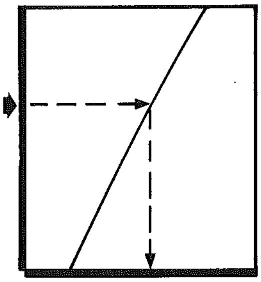
PULLOUT ACCELERATION 3.0 g ATTAINED IN 2.0 s



ALTITUDE LOST DURING PULLOUT - FEET

Figure 6-2. (Sheet 1)

DIVE RECOVERY CHART



PULLOUT ACCELERATION 3.5 g ATTAINED IN 2.0 s

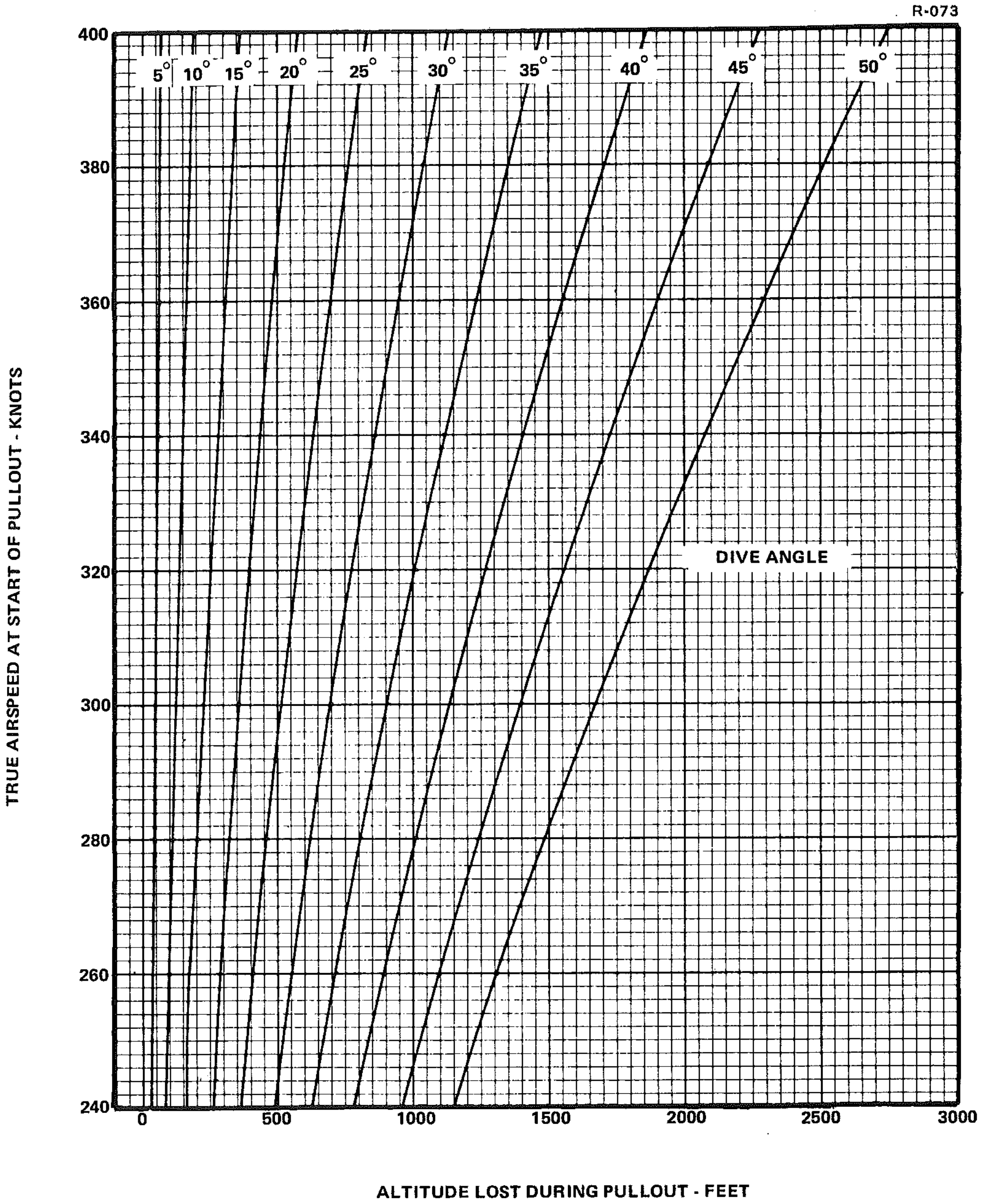
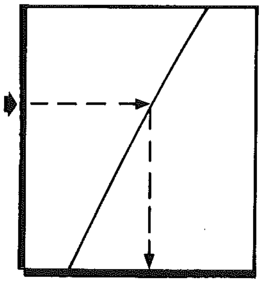


Figure 6-2. (Sheet 2)

DIVE RECOVERY CHART



PULLOUT ACCELERATION 4.0 ATTAINED IN 2.0 s

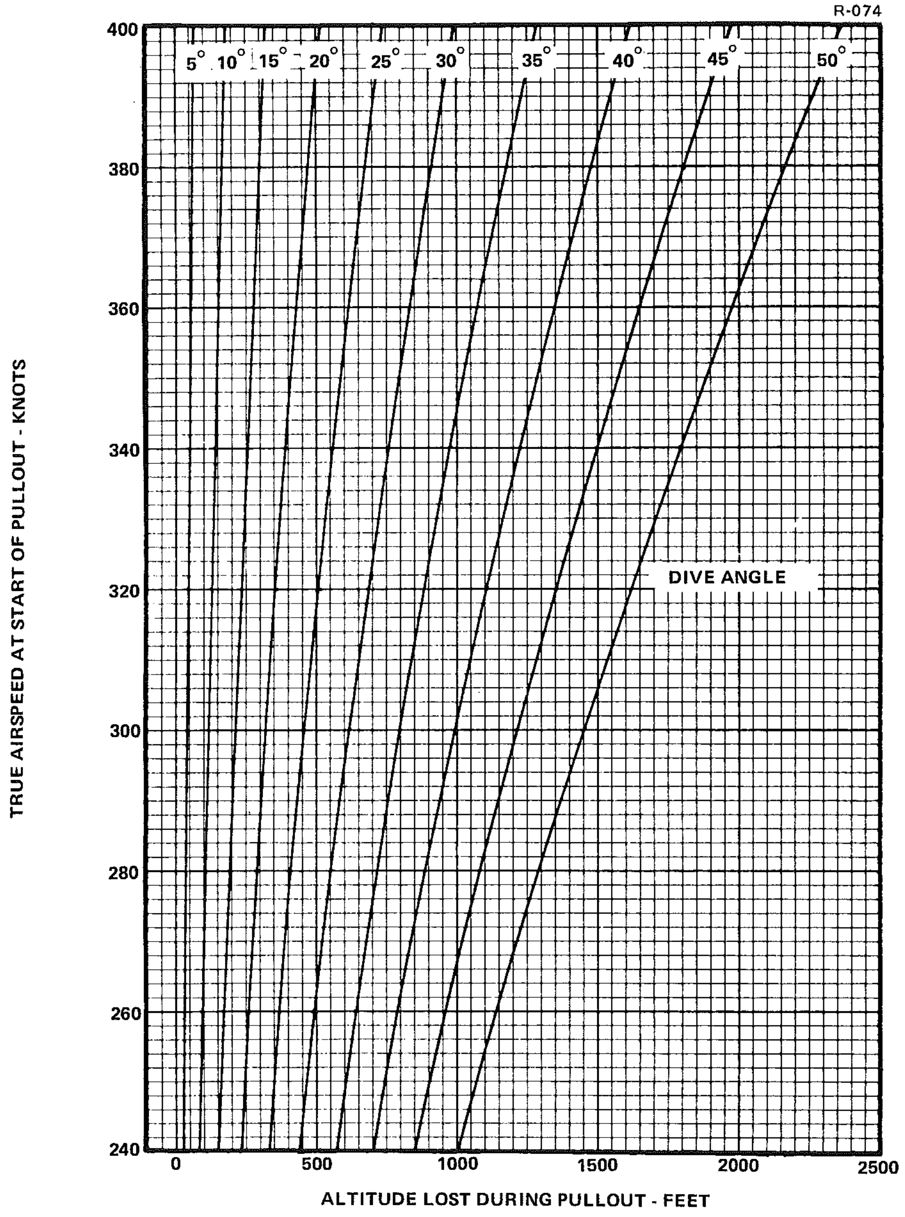


Figure 6-2. (Sheet 3)

ZERO SIGHT LINE ANGLE OF ATTACK

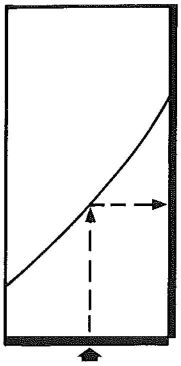
THE VALUES ARE IN MILS

KIAS	GROSS MASS 8 000 LB							GROSS MASS 9 000 LB							GROSS MASS 10 000 LB							GROSS WT 11 000 LB						
	DIVE ANGLE - DEGREES							DIVE ANGLE - DEGREES							DIVE ANGLE - DEGREES							DIVE ANGLE - DEGREES						
	0	10	20	30	40	50	60	0	10	20	30	40	50	60	0	10	20	30	40	50	60	0	10	20	30	40	50	60
240	26	25	24	21	17	12	7	31	30	28	25	21	15	9	37	36	33	30	25	19	12	42	41	39	35	30	23	15
260	19	18	17	15	12	8	3	23	22	20	18	14	10	4	27	26	25	22	18	13	7	32	31	29	26	22	16	10
280	14	13	12	10	7	4	0	17	16	15	13	10	6	2	20	19	18	16	13	8	4	25	24	22	20	17	11	6
300	9	8	7	6	4	1	-2	12	12	11	9	6	3	-1	15	14	13	11	8	5	1	19	18	16	14	11	7	2
320	6	5	4	3	1	-1	-4	8	8	7	5	3	0	-3	11	10	9	8	6	3	-1	14	14	12	10	7	4	0
340	3	3	2	1	-1	-3	-6	6	5	4	3	1	-1	-4	8	7	6	4	2	0	-3	10	10	9	7	5	2	-2
360	1	1	0	-1	-3	-5	-7	3	2	2	1	-1	-3	-6	5	5	4	3	1	-2	-4	8	7	6	5	3	0	-3
380	-1	-1	-2	-3	-4	-6	-8	1	0	0	-1	-3	-6	-7	3	2	2	1	-1	-3	-6	5	4	3	2	0	-2	-5
400	-2	-2	-3	-4	-5	-7	-9	-1	-1	-2	-3	-4	-5	-7	1	0	0	-1	-3	-5	-7	3	3	2	0	-1	-3	-6

Figure 6-3.

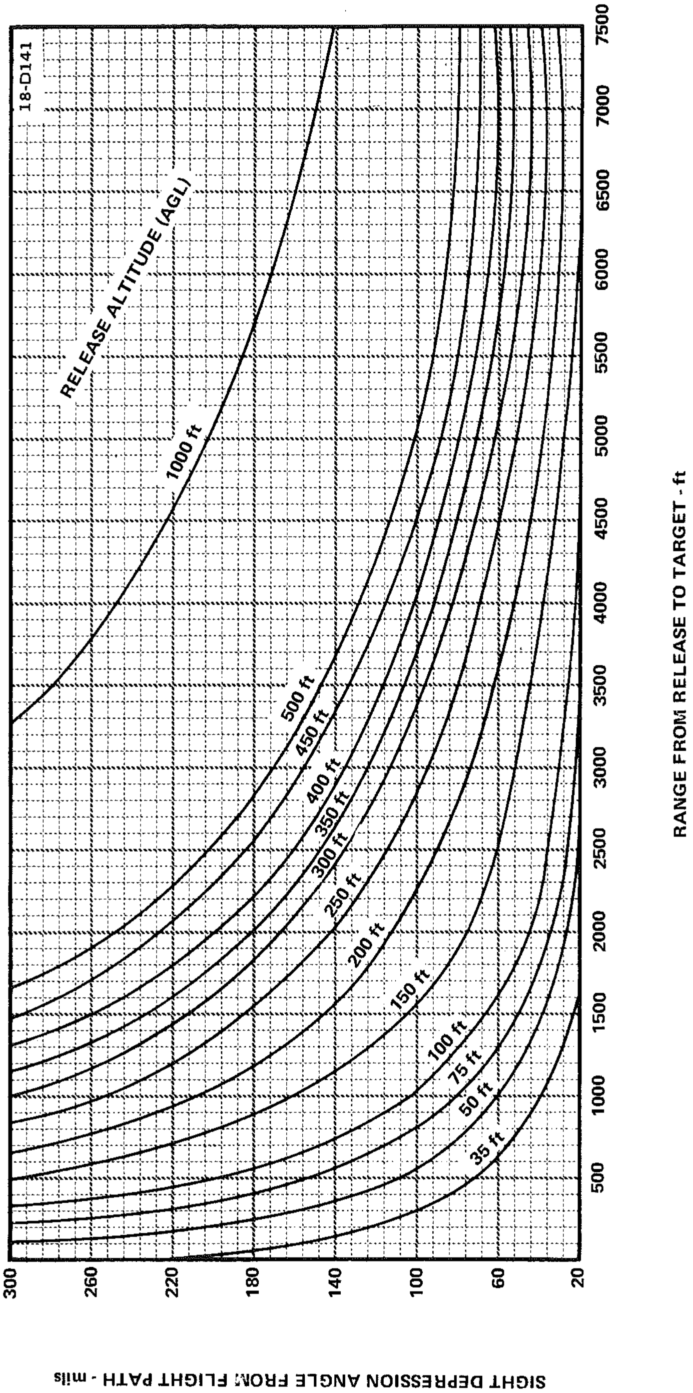
NOTE

GBSL, RLL and ZSL are set at 26.2 mils above FRL



HORIZONTAL RANGE CHART

LEVEL RELEASE CONDITIONS



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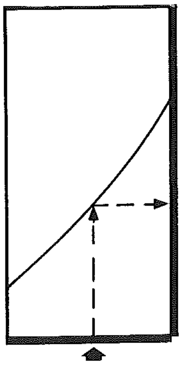


HORIZONTAL RANGE CHART

5° DIVE RELEASE CONDITIONS

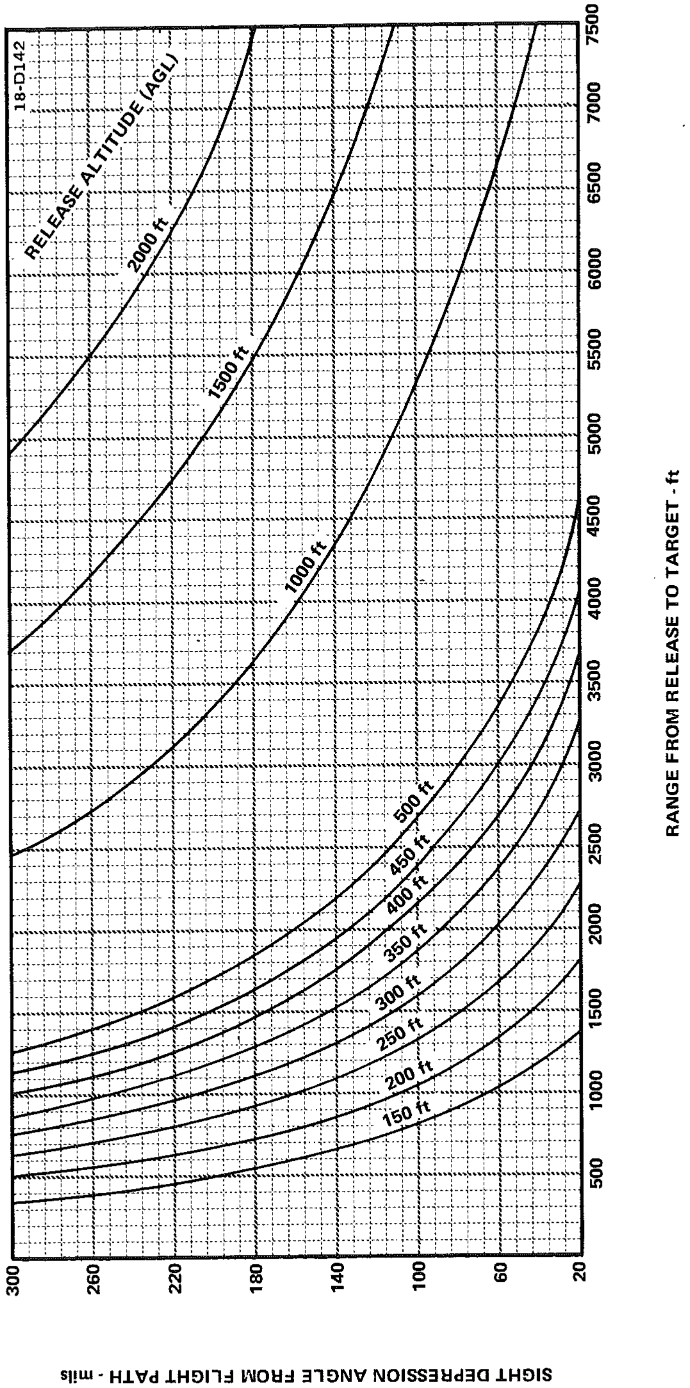
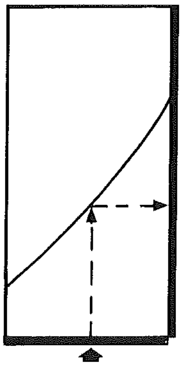


Figure 6-4. (Sheet 2)



HORIZONTAL RANGE CHART

10° DIVE RELEASE CONDITIONS

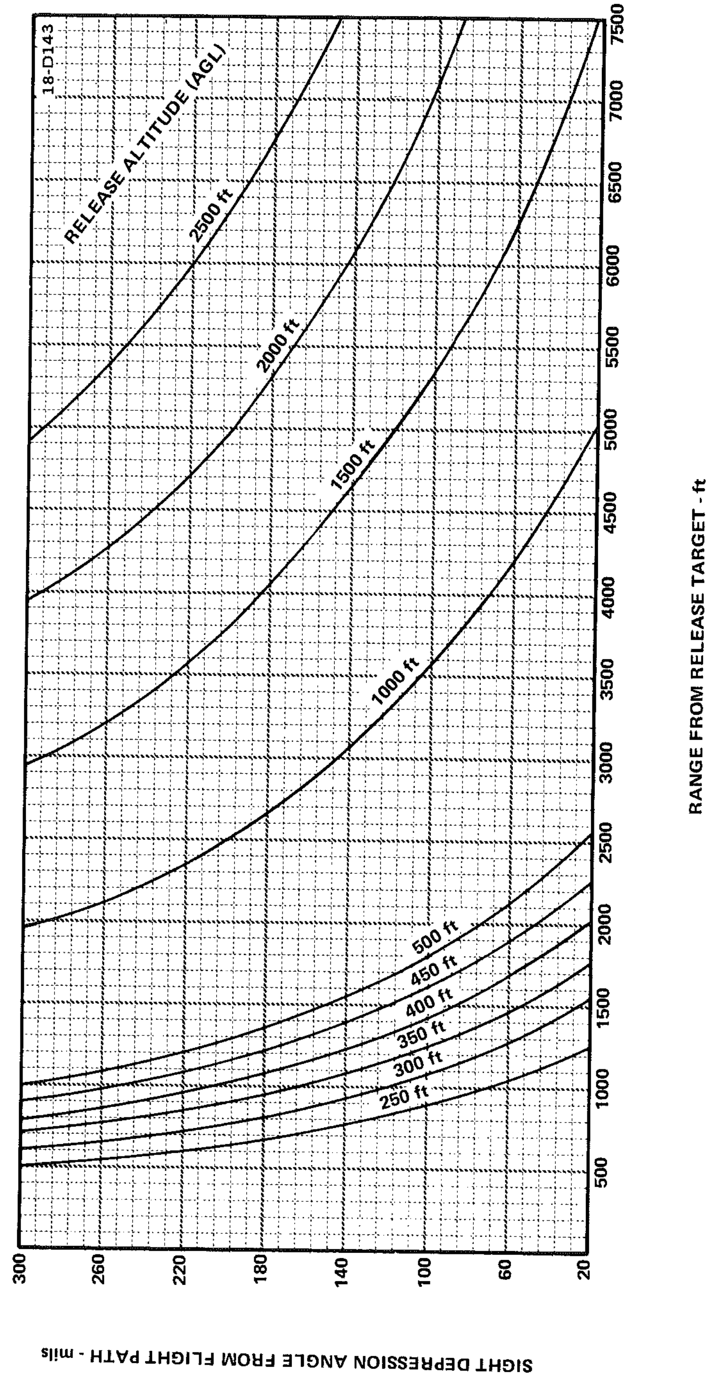
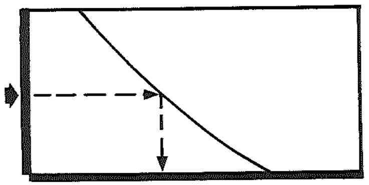


Figure 6-4. (Sheet 3)

HORIZONTAL RANGE CHART

15° DIVE RELEASE CONDITIONS



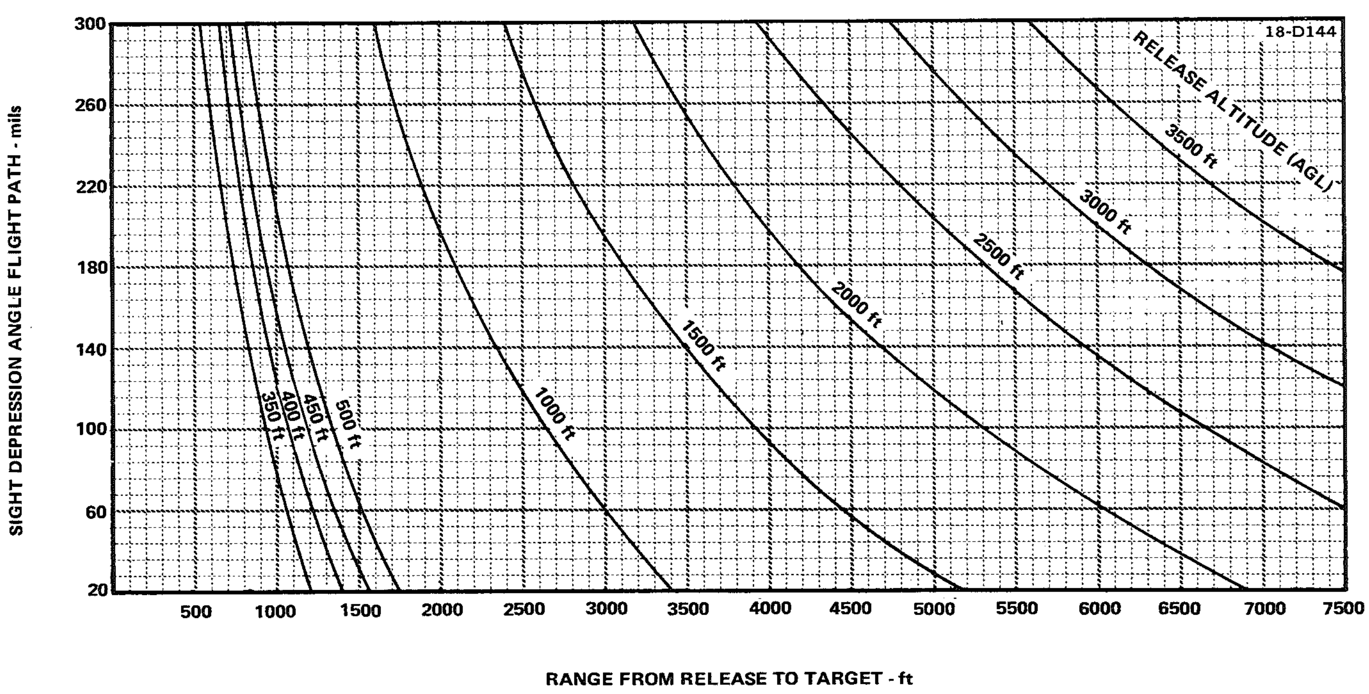
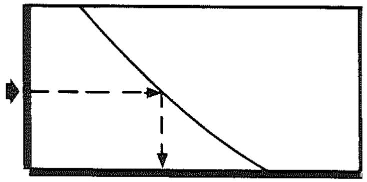
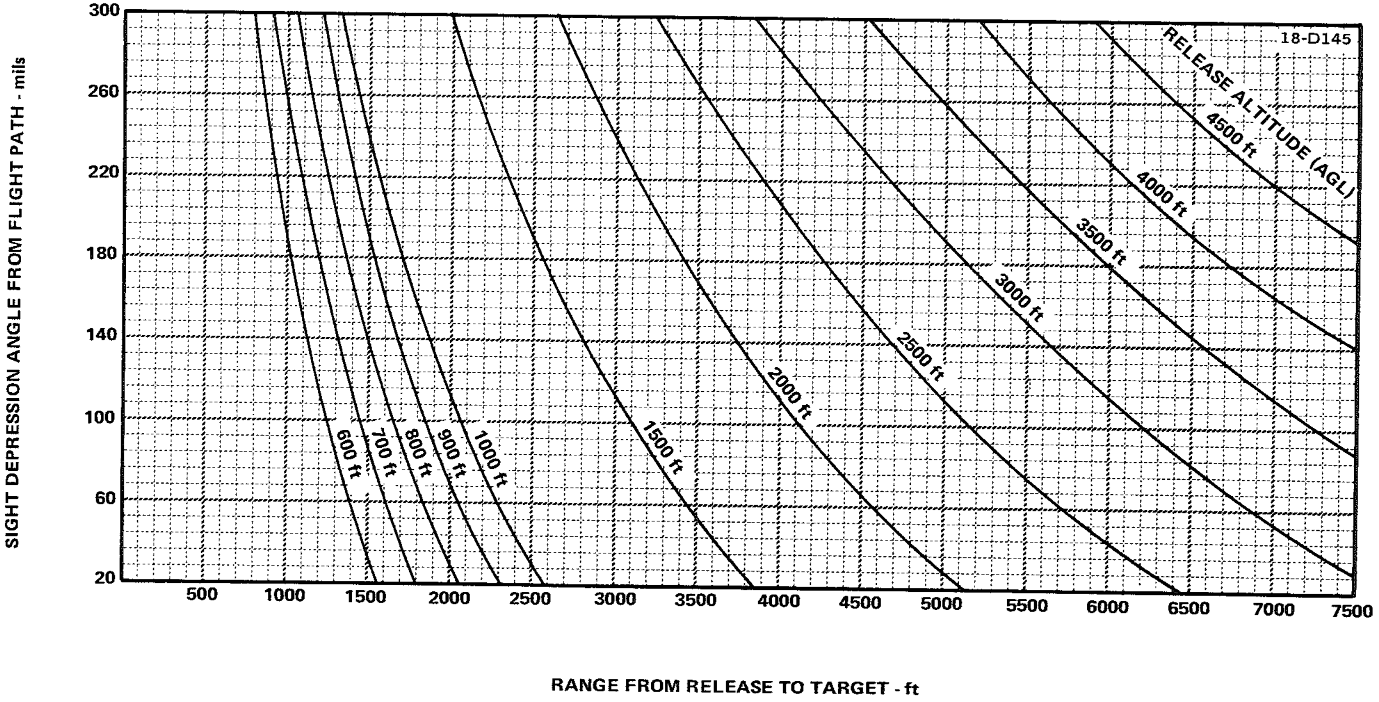


Figure 6-4. (Sheet 4)

HORIZONTAL RANGE CHART

20° DIVE RELEASE CONDITIONS





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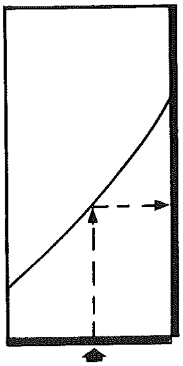


HORIZONTAL RANGE CHART

25° DIVE RELEASE CONDITIONS

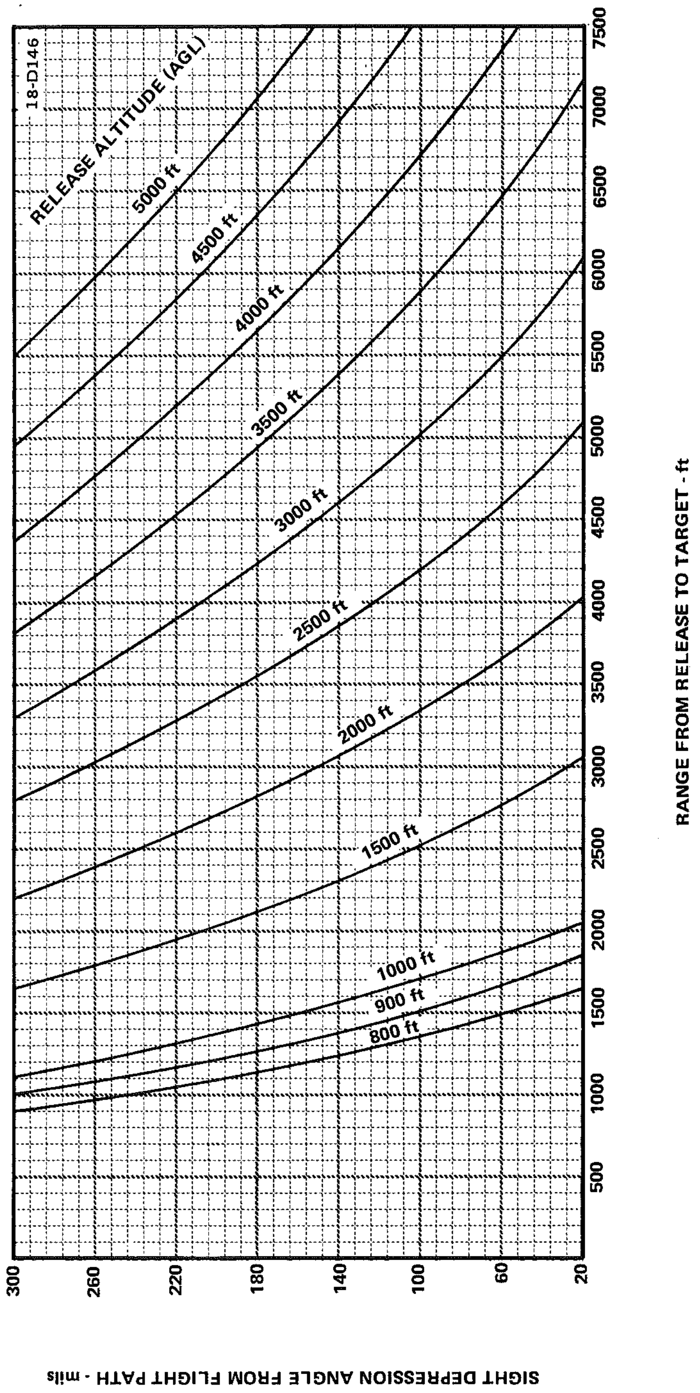
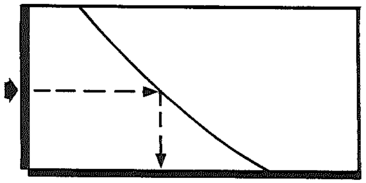
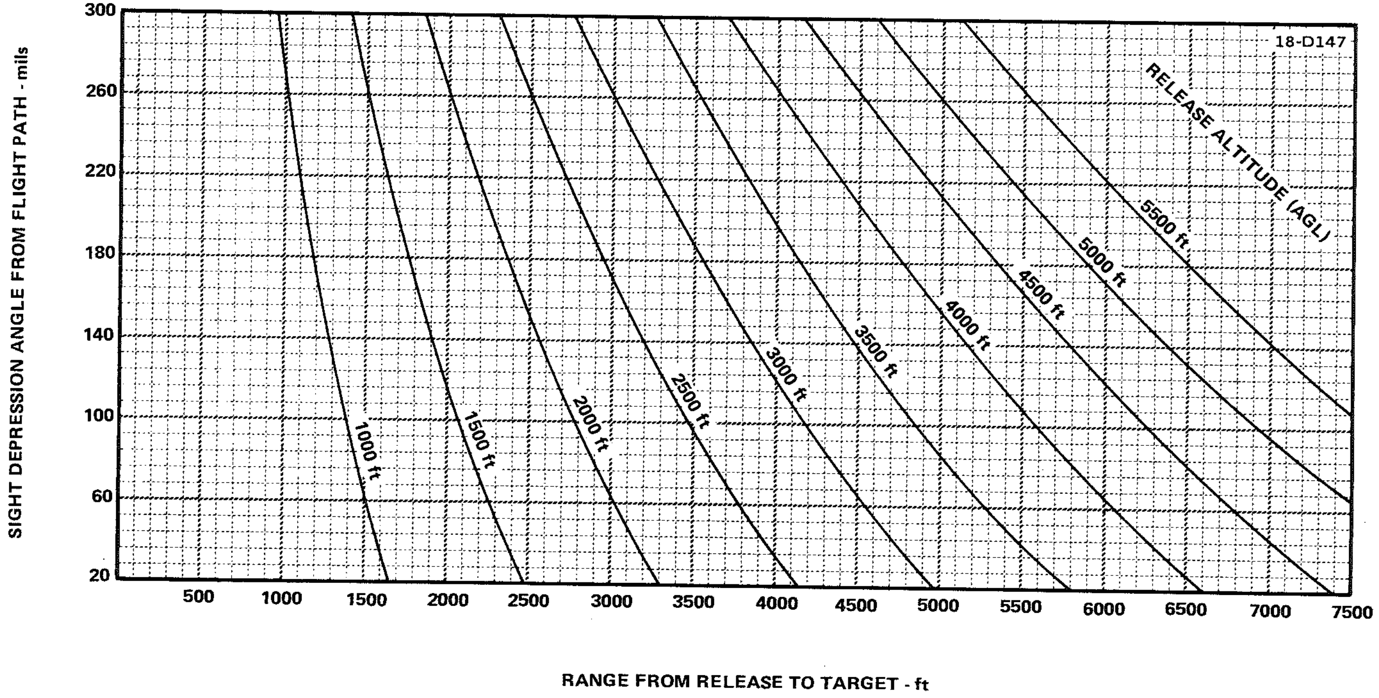


Figure 6-4. (Sheet 6)

HORIZONTAL RANGE CHART

30° DIVE RELEASE CONDITIONS





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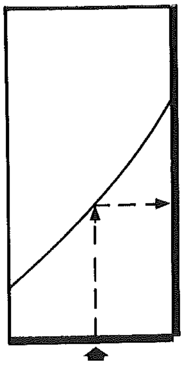


HORIZONTAL RANGE CHART

35° DIVE RELEASE CONDITIONS

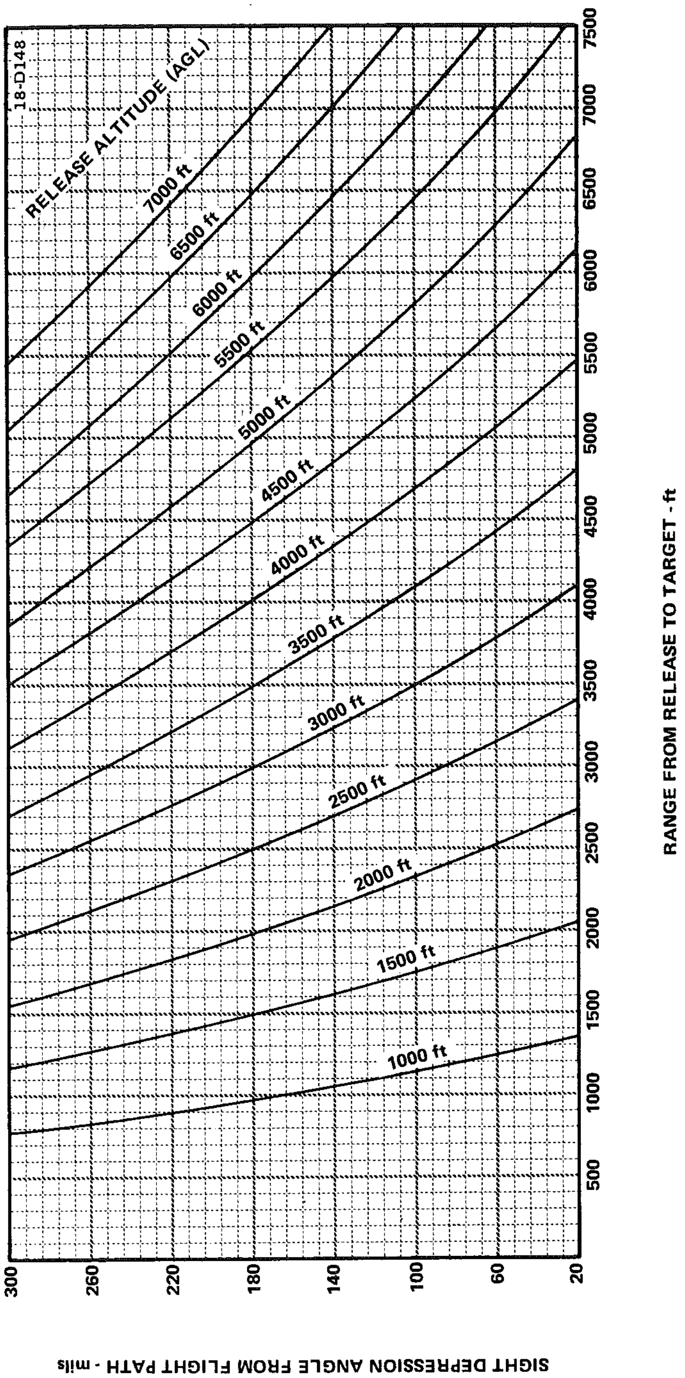
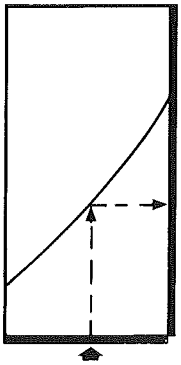


Figure 6-4. (Sheet 8)

HORIZONTAL RANGE CHART

40° DIVE RELEASE CONDITIONS



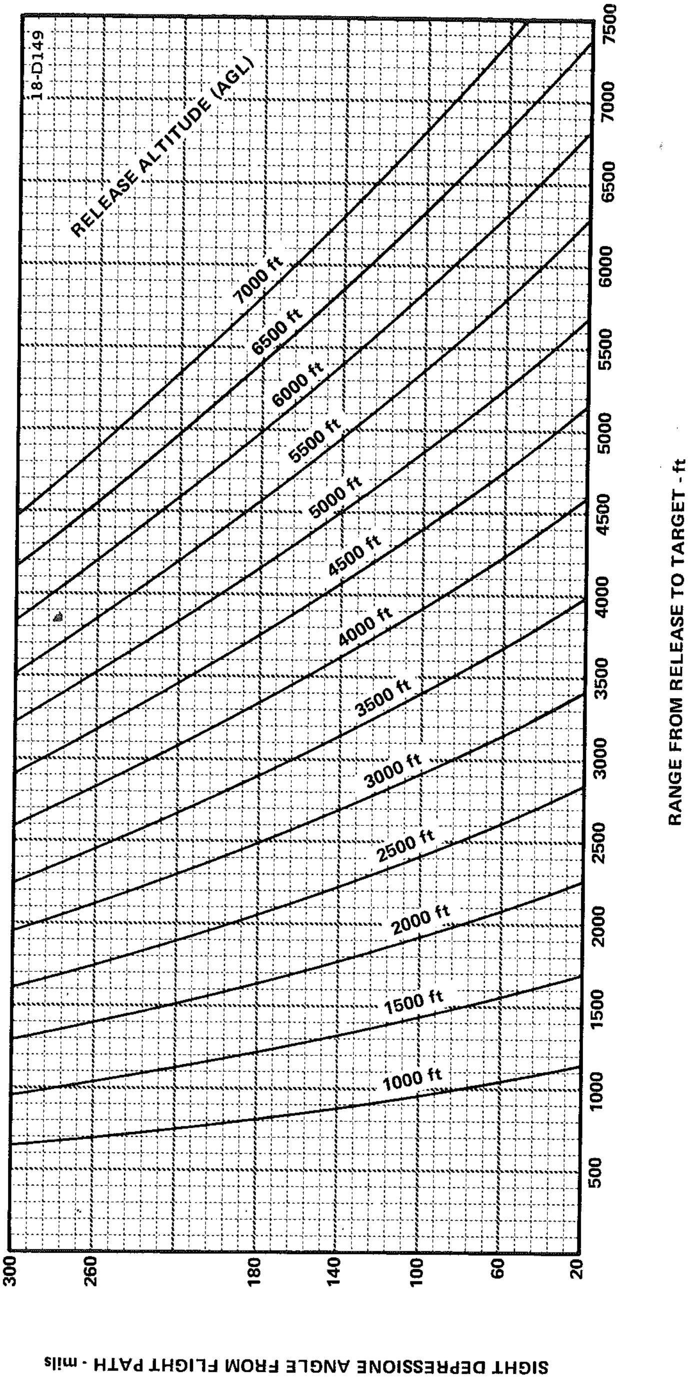
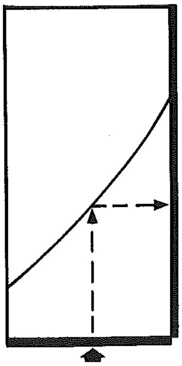


Figure 6-4. (Sheet 9)



HORIZONTAL RANGE CHART

45° DIVE RELEASE CONDITIONS

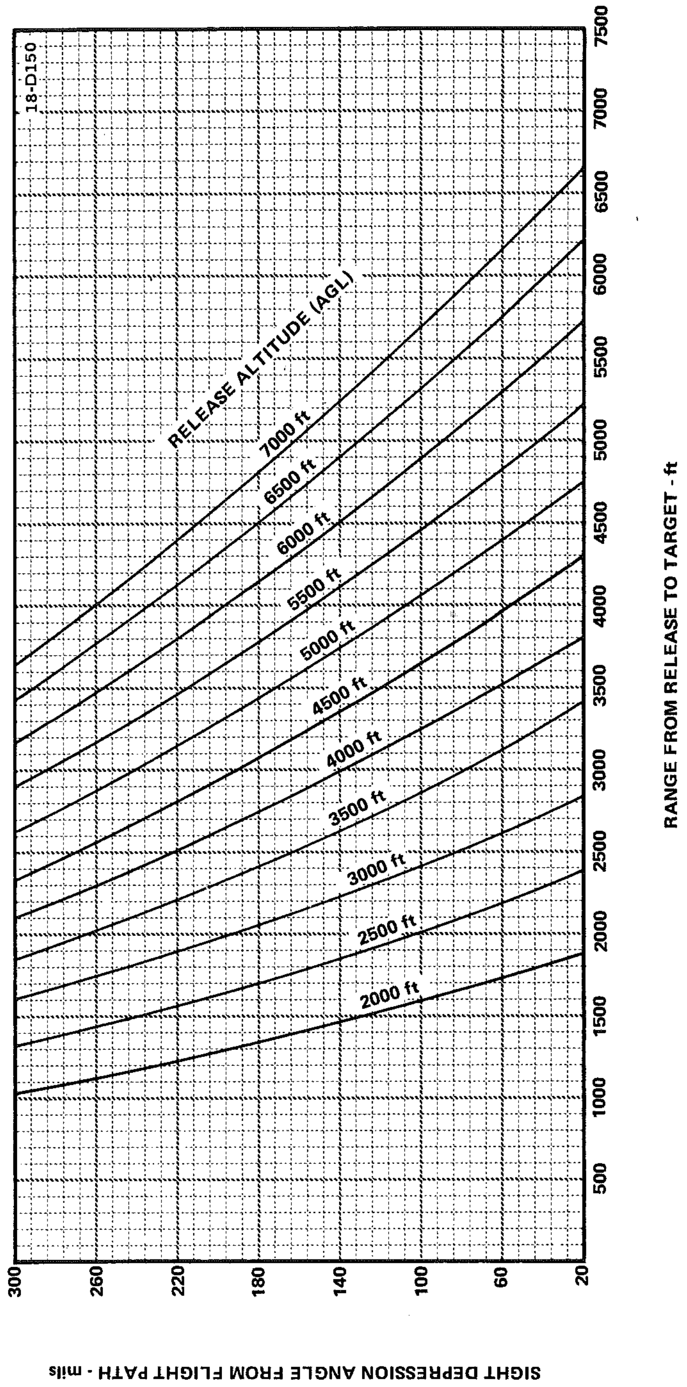
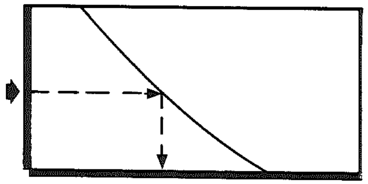


Figure 6-4. (Sheet 10)

HORIZONTAL RANGE CHART

50° DIVE RELEASE CONDITIONS



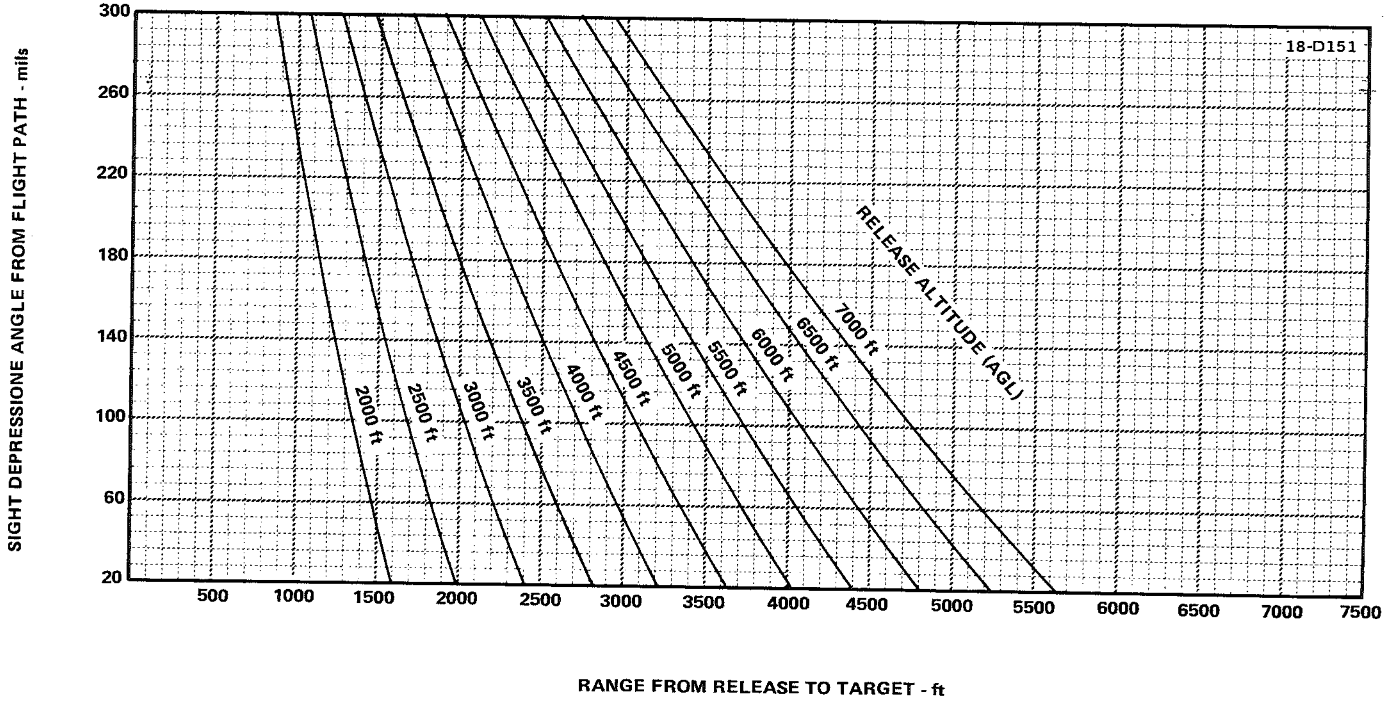
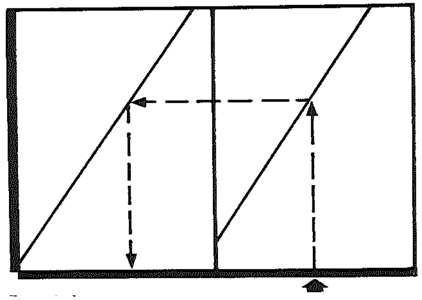


Figure 6-4. (Sheet 11)

AISPEED CONVERSION CHART



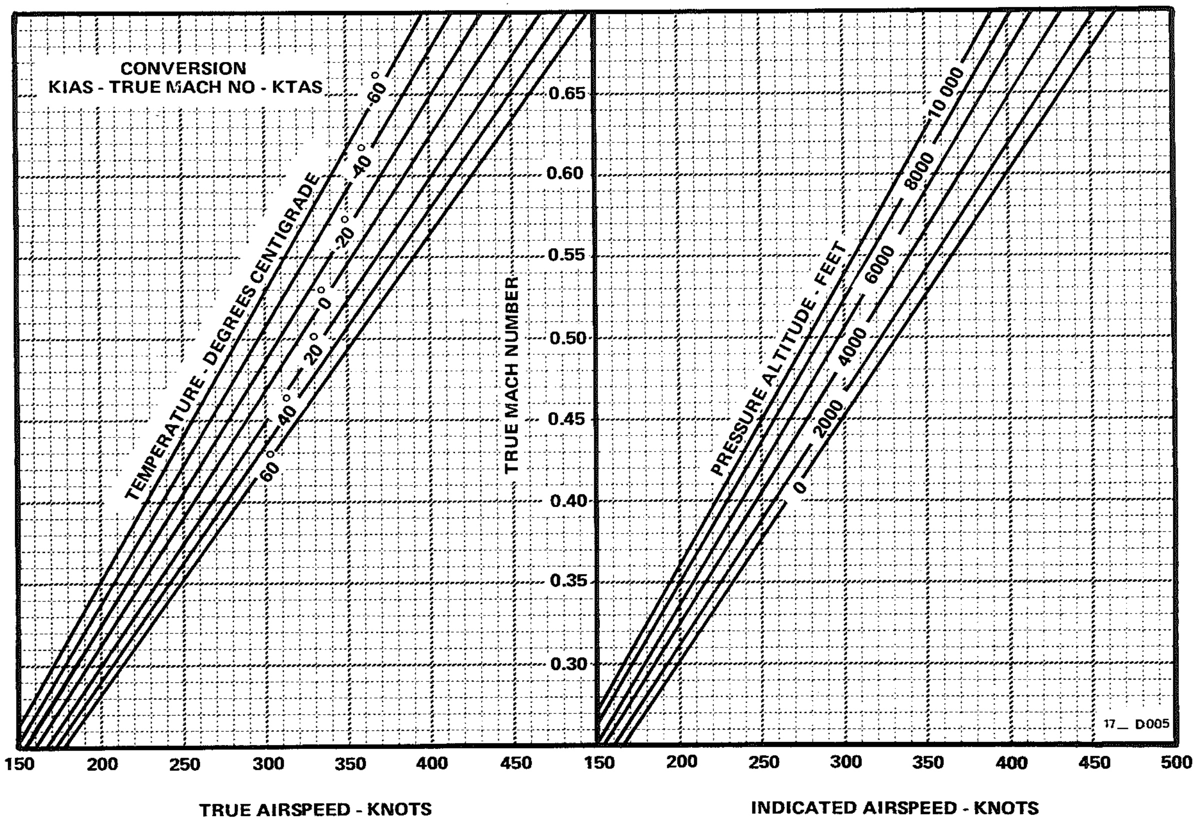
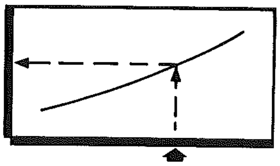


Figure 6-5.

ALTIMETER CORRECTION CHART



CRUISE CONFIGURATION

NOTE

ADD CORRECTION TO OBTAIN TRUE PRESSURE ALTITUDE.

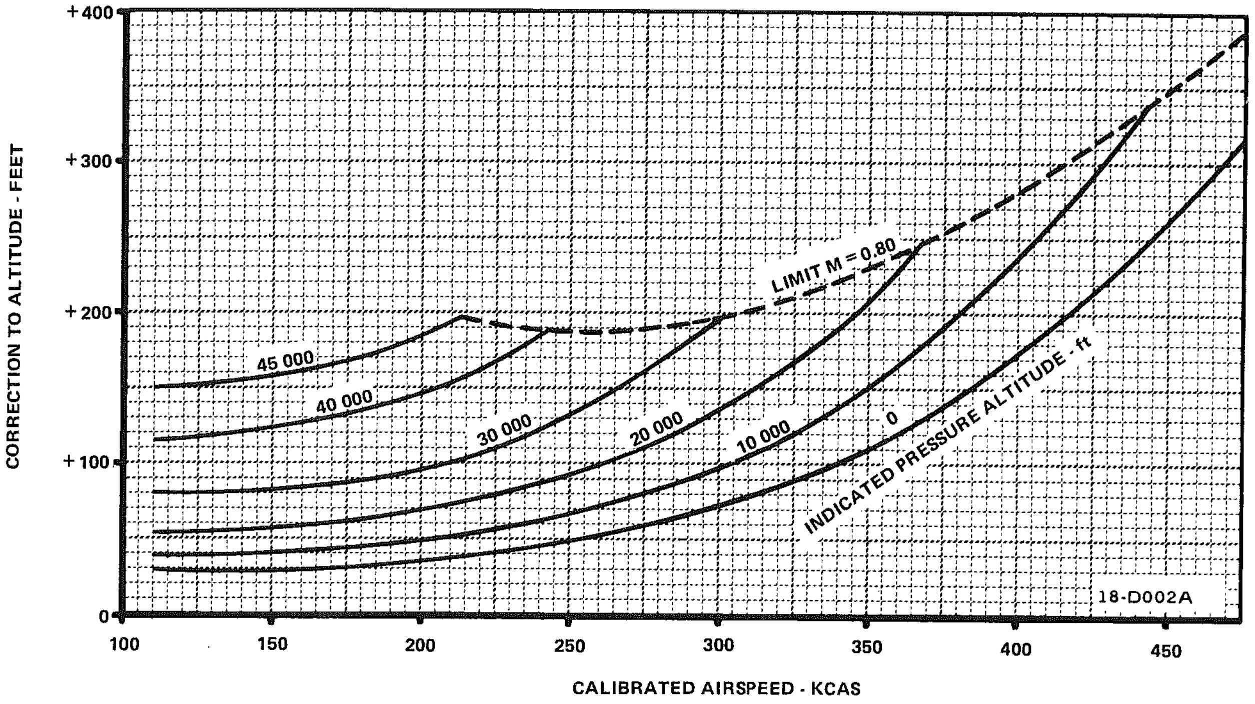
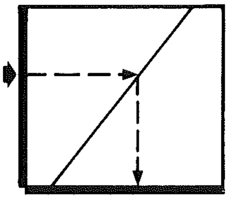


Figure 6-6.

ALTIMETER LAG CHART



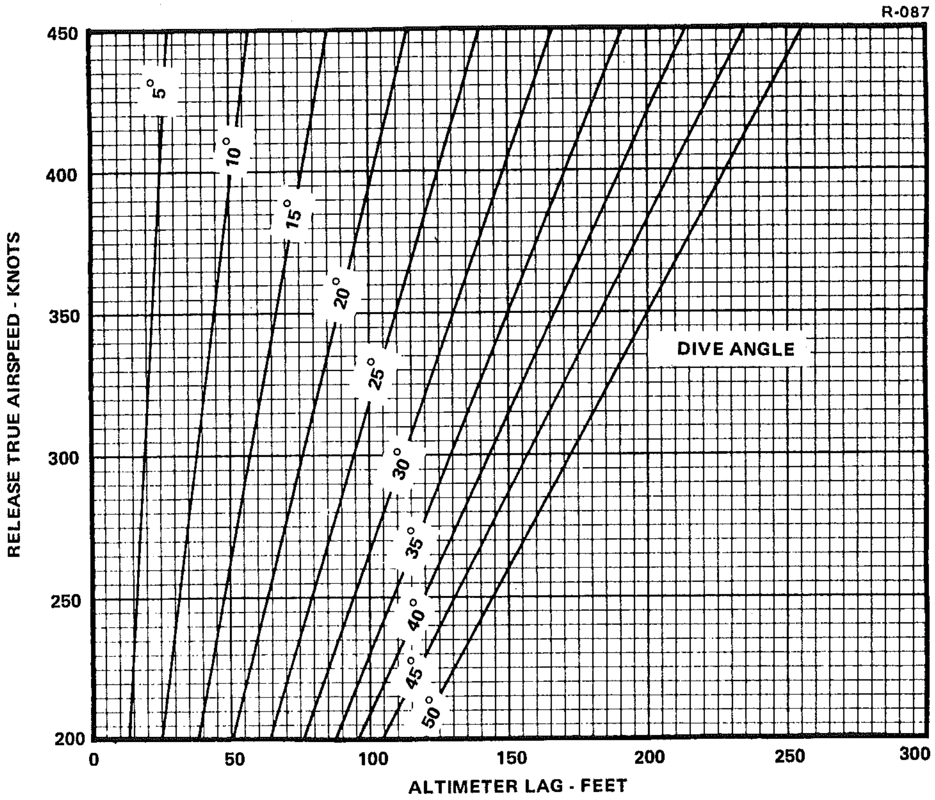
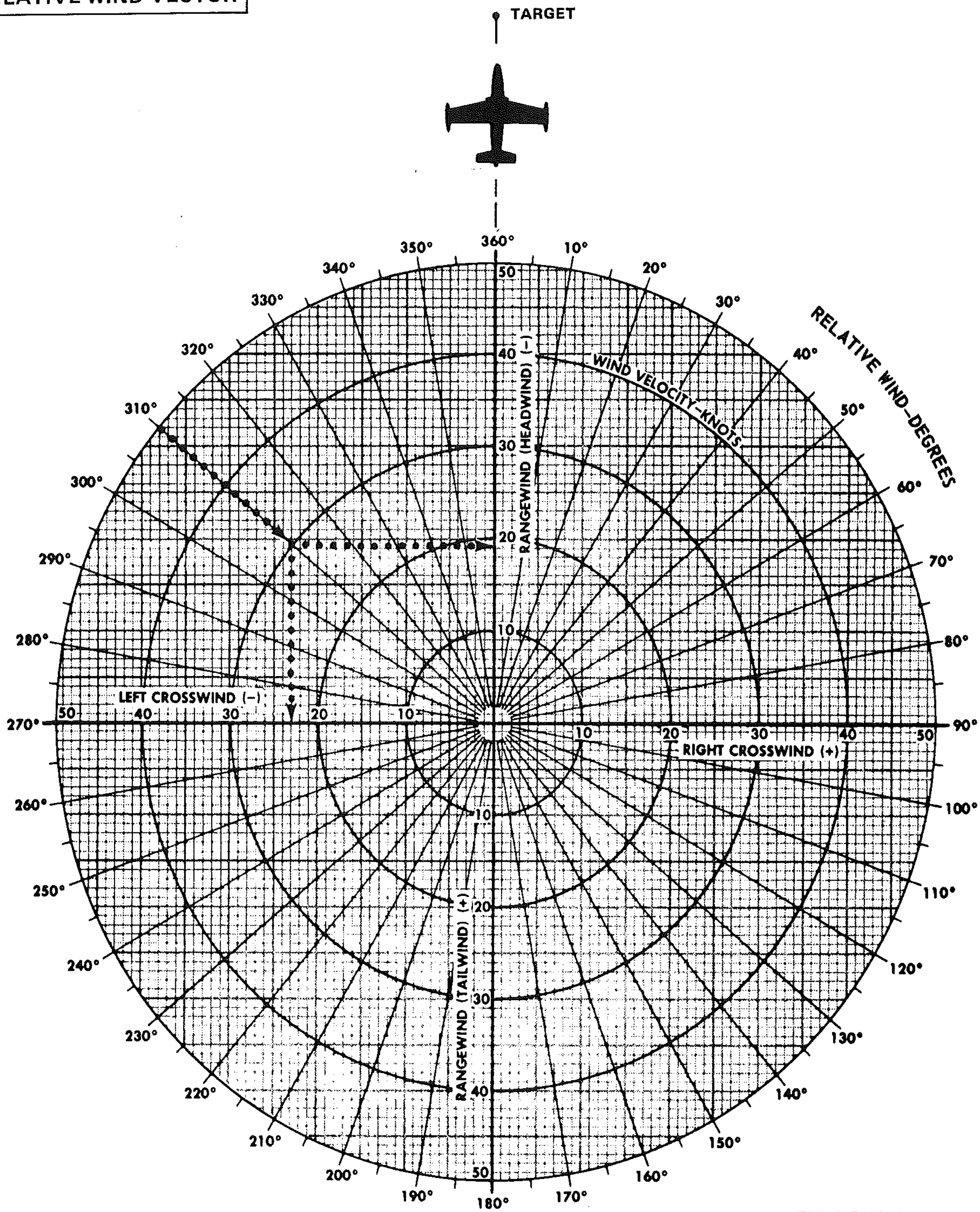


Figure 6-7.

RELATIVE WIND VECTOR



EXAMPLE No. 1

GIVEN:
a. WIND DIRECTION. . . . . .350°
b. APPROACH COURSE . . . . -040°
FIND: RELATIVE WIND . . . . .310°

EXAMPLE No. 2

GIVEN:
a. WIND DIRECTION. . . . . .040°
b. APPROACH COURSE . . . . .350°
(Since 350° is greater then 040°, add 360° to the wind direction.)
c. WIND DIRECTION. . . . . .400°
d. APPROACH COURSE . . . . -350°
FIND: RELATIVE WIND . . . . .050°

Figure 6-8.

PARALLAX CORRECTION TO BOMB RANGE

DIVE ANGLE	X PARALLAX X COS DIVE ANGLE	Z PARALLAX X SIN DIVE ANGLE	CORRECTION TO BOMB RANGE (FT)
0°	- 10.8	- 0	- 11
10°	- 10.63	- 0.669	- 11
20°	- 10.14	- 1.323	- 11
30°	- 9.35	- 1.935	- 11
40°	- 8.27	- 2.488	- 11
50°	- 6.94	- 2.964	- 10
60°	- 5.40	- 3.335	- 9

Figure 6-9.

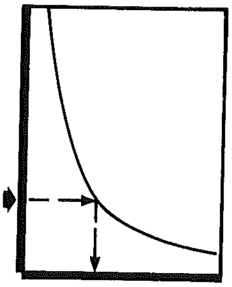
PARALLAX CORRECTION TO RELEASE ALTITUDE

DIVE ANGLE	X PARALLAX X COS DIVE ANGLE	Z PARALLAX X SIN DIVE ANGLE	CORRECTION TO RELEASE ALT (FT)
0°	- 0	+ 3.87	- 4
10°	- 1.868	+ 3.808	- 2
20°	- 3.693	+ 3.633	0
30°	- 5.400	+ 3.351	+ 2
40°	- 6.944	+ 2.964	+ 4
50°	- 8.272	+ 2.488	+ 6
60°	- 9.352	+ 1.935	+ 7

Figure 6-10.

PARALLAX CORRECTION TO SIGHT SETTING

- **FIXED GUNSIGHT**
- **BOMBS**



(Gun and Rocket Tables of Volume 2 are already corrected for Parallax)

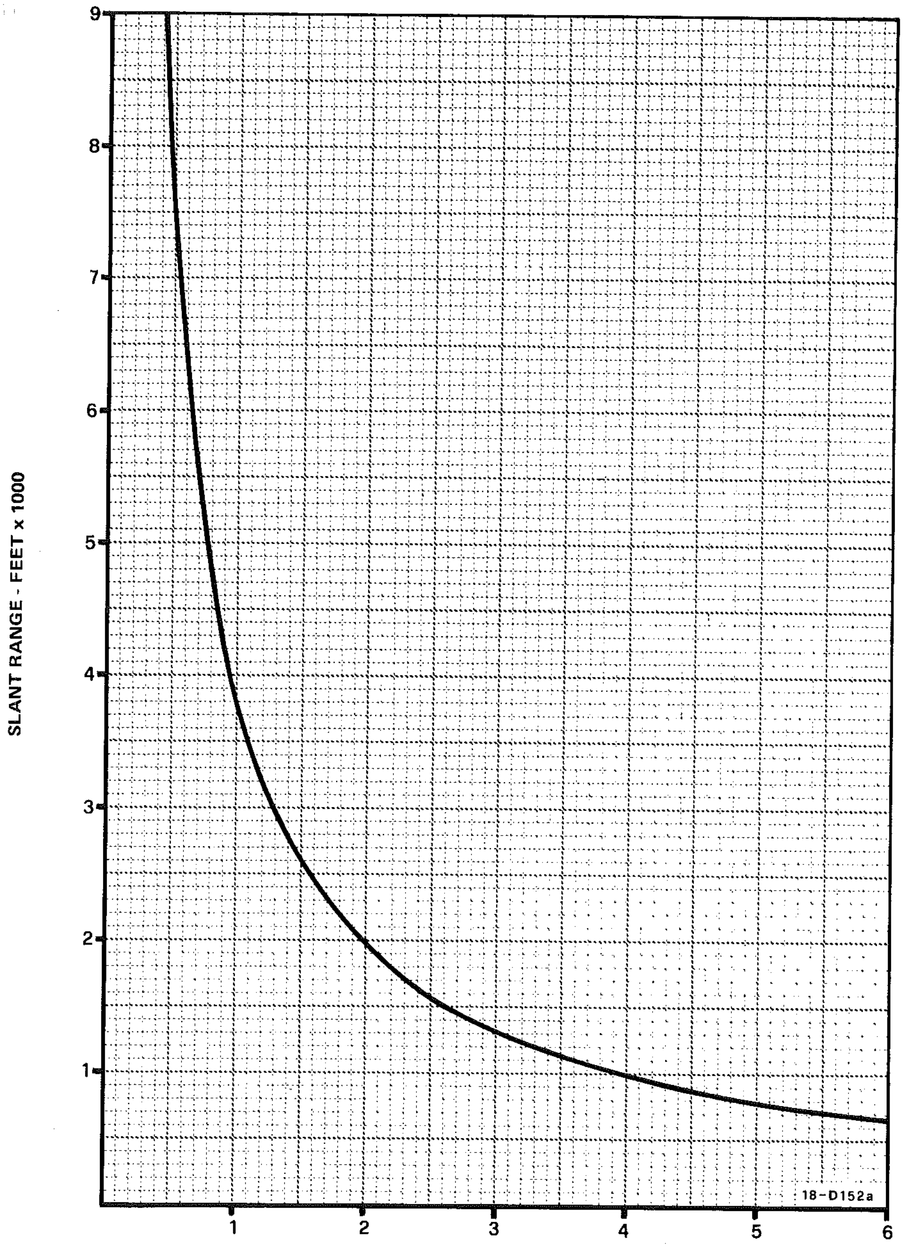


Figure 6-11.

ROCKETS TARGET ALTITUDE CORRECTION TO SIGHT SETTING

TGT ALTITUDE FT ABOVE S.L.	SLANT RANGE THOUSANDS OF FEET									
	1.8	2.4	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
2000	0	0	0	0	0	1	1	1	1	1
4000	0	0	1	1	1	1	1	2	2	2
6000	0	1	1	1	1	2	2	3	3	3
8000	1	1	1	1	2	3	3	3	4	4
10000	1	1	2	2	2	3	3	4	5	5

Figure 6-12.

VELOCITY JUMP FACTOR

TAS KNOTS	TAS FT/SEC	TAS + M_V FT/SEC	Vjf
240	405	3,105	0.1300
260	438	3,138	0.1395
280	472	3,172	0.1490
300	506	3,206	0.1580
320	540	3,240	0.1660
340	574	3,274	0.1775
360	607	3,307	0.1835
380	641	3,341	0.1920
400	675	3,375	0.2000
420	709	3,409	0.2080
440	743	3,443	0.2158

Figure 6-13.

WINDSHIELD REFRACTION CORRECTION TO SIGHT SETTING

- 19 mm THICK WINDSHIELD
- BOMBING

NOTE

Firing tables concerning guns and rockets are already corrected for windshield refraction.

SIGHT SETTING MILS	CORRECTION MILS -ADD-	SIGHT SETTING MILS	CORRECTION MILS -ADD-
0 TO 30	0	131 TO 160	4
31 TO 60	0	161 TO 180	5
61 TO 100	2	181 TO 200	6
101 TO 130	3	ABOVE 200	7

Figure 6-14.

MINIMUM LAUNCH ALTITUDES FOR SAFE RECOVERY FROM FRAGMENTS

2.75 FFAR W/MK 1 AND MK 5 WARHEAD
4.0 G RECOVERY TO 20 DEG - 30 DEG CLIMB

RELEASE KTAS	RELEASE DIVE ANGLE - DEGREE					
	10	15	20	30	45	60
240	500	700	900	1200	1700	2300
280	600	800	1000	1300	1800	2400
320	600	800	1100	1400	2000	2600
360	600	900	1200	1600	2200	2800
400	700	900	1300	1800	2400	3200

2.75 FFAR W/M151 WARHEAD
4.0 G RECOVERY TO 20 DEG - 30 DEG CLIMB

RELEASE KTAS	RELEASE DIVE ANGLE - DEGREE					
	10	15	20	30	45	60
240	500	600	800	1100	1600	2300
280	500	700	900	1200	1700	2400
320	500	700	1000	1300	1900	2600
360	500	700	1100	1500	2100	2800
400	600	800	1200	1700	2300	3200

Figure 6-15.

ROCKET LAUNCH "F" FACTOR

RELEASE KTAS	240	280	320	360	400
FFAR (20°C)	0.744	0.772	0.800	0.828	0.856
FFAR (0°C)	0.764	0.729	0.820	0.848	0.866
ZUNI (20°C)	0.580	0.616	0.655	0.687	0.715
SCAR	0.780	0.820	0.840	0.860	0.880

Figure 6-16.

MINIMUM RELEASE ALTITUDE FOR FUZE ARMING

- **GENERAL PURPOSE AND LOW DRAG BOMBS**

RELEASE		M904 NOSE OR M905 TAIL FUZE	
TAS KTS	DIVE ANGLE DEG	4-SEC ARMING DELAY SETTING FT	6-SEC ARMING DELAY SETTING FT
240	15	880	1575
240	20	1031	1820
240	25	1195	2045
240	30	1340	2270
240	35	1475	2480
240	40	1610	2680
240	45	1735	2865
240	50	1845	3030
280	15	955	1700
280	20	1145	1975
280	25	1325	2245
280	30	1495	2500
280	35	1660	2750
280	40	1815	2980
280	45	1960	3195
280	50	2090	3390
320	15	1034	1820
320	20	1255	2135
320	25	1455	2455
320	30	1655	2470
320	35	1840	3015
320	40	2015	3285
320	45	2185	3525
320	50	2330	3755
360	15	1120	1940
360	20	1360	2295
360	25	1585	2640
360	30	1815	2970
360	35	2020	3345
360	40	2220	3585
360	45	2405	3860
360	50	2575	4110
400	15	1205	2055
400	20	1460	2450
400	25	1720	2835
400	30	1965	3205
400	35	2200	3555
400	40	2420	3885
400	45	2630	4190
400	50	2820	4470

Figure 6-17.

MINIMUM RELEASE ALTITUDE FOR SAFE ESCAPE

- **4.0 g PULL-UP ATTAINED IN 2 s**

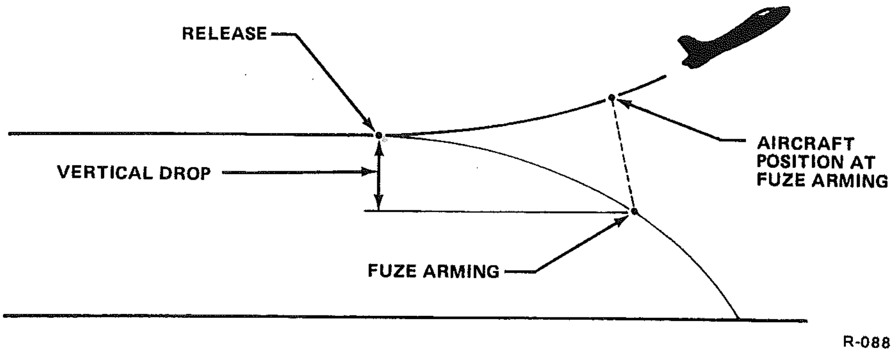
RELEASE		ALTITUDE LOST DURING PULL-OUT	MINIMUM REL. ALT FOR FRAGMENTATION ENVELOPE CLEARANCE		
TAS	DIVE ANGLE		GP BOMBS 750-500 LBS	MK-82 BOMB	MK-81 BOMB
KTS	DEG	FT	FT	FT	FT
240	15	150	1000	900	1000
240	20	230	1200	1000	1100
240	25	330	1300	1200	1200
240	30	440	1500	1300	1400
240	35	570	1600	1400	1500
240	40	700	1700	1500	1600
240	45	800	1800	1700	1600
240	50	1000	1900	1800	1700
280	15	190	1000	900	900
280	20	290	1200	1100	1000
280	25	420	1400	1200	1200
280	30	560	1600	1400	1400
280	35	710	1700	1500	1500
280	40	890	1900	1700	1700
280	45	1080	2000	1800	1800
280	50	1290	2100	1900	1900
320	15	230	1100	1000	900
320	20	360	1300	1100	1100
320	25	510	1500	1300	1300
320	30	690	1700	1500	1500
320	35	890	1900	1700	1700
320	40	1110	2000	1800	1800
320	45	1350	2200	2000	1900
320	50	1620	2300	2100	2100
360	15	280	1100	1000	1000
360	20	430	1400	1200	1200
360	25	620	1600	1400	1400
360	30	830	1800	1600	1500
360	35	1080	2000	1800	1700
360	40	1350	2200	2000	1900
360	45	1650	2400	2200	2000
360	50	1980	2500	2300	2200
400	15	320	1200	1100	1000
400	20	510	1400	1300	1200
400	25	730	1700	1500	1400
400	30	990	1900	1700	1600
400	35	1290	2100	1900	1800
400	40	1610	2300	2100	2000
400	45	1970	2500	2300	2200
400	50	2360	2700	2400	2400

Note: For bombs smaller than 500 lb the safety clearance is greater

Figure 6-18.

SAFE ESCAPE FOR LEVEL RELEASE

- MAXIMUM POWER AND 4 g MAINTAINED UNTIL 20° CLIMB OUT ANGLE IS ATTAINED



RELEASE	MINIMUM REL ALT FOR FRAGMENTATION ENVELOPE CLEARANCE		
TAS KTS	M117 BOMB FT	MK-82 BOMB FT	MK-81 BOMB FT
240	600	500	500
280	500	400	400
320	500	400	400
360	400	400	300
400	400	400	400
	STRAIGHT AND LEVEL CONSTANT SPEED		
240	1500	1200	1200
280	1400	1200	1100
320	1300	1200	1000
360	1100	1100	900
400	1000	1000	900

- STRAIGHT AND LEVEL CONSTANT SPEED

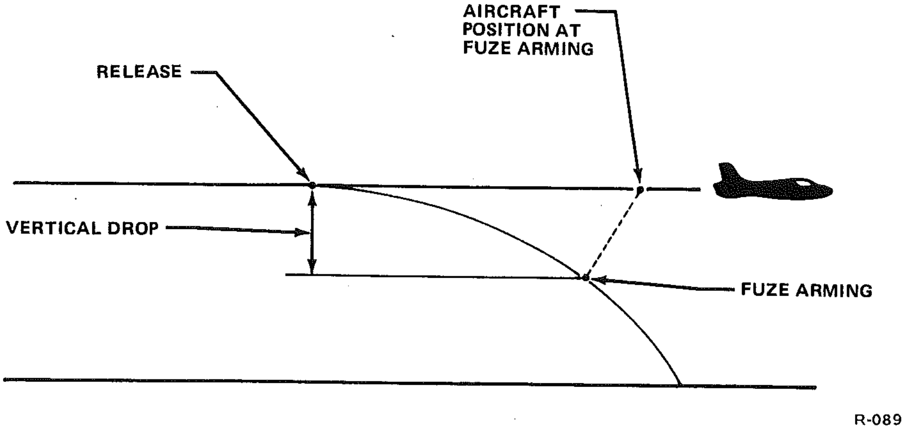


Figure 6-19.

FUZE ARMING DISTANCE

- **LOW ALTITUDE LEVEL RELEASE AND LEVEL CONSTANT SPEED ESCAPE MANEUVER**

REL KTAS	SAFE ARMING TIME SEC	VERTICAL DROP TO FUZE ARMING FT	AIRCRAFT TO BOMB SLANT RANGE DISTANCE AT FUZE ARMING FT
GP BOMBS			
260 320 380	9.4 9.1 8.3	1400 1300 1100	1402 1304 1107
MK 81, MK 82			
260 320 380	8.7 8.7 8.0	1200 1200 1000	1202 1203 1005

NOTE

The values listed are applicable for use with single, pairs, or salvo releases. A straight and level, constant speed, escape maneuver is assumed after release.

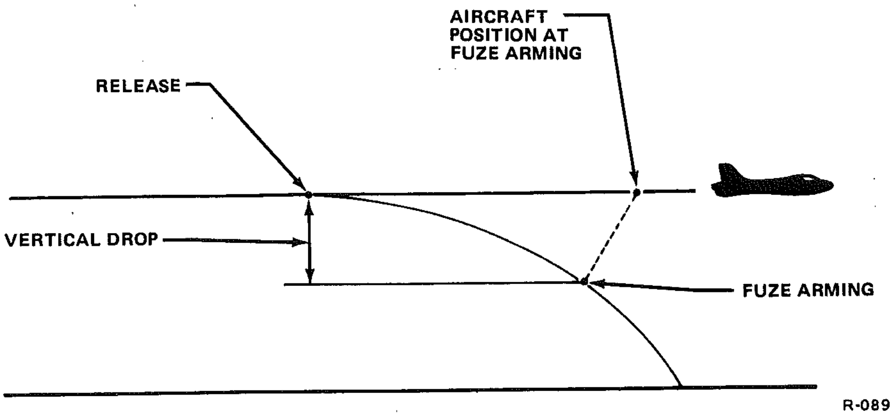


Figure 6-20. (Sheet 1)

FUZE ARMING DISTANCE

- **LOW ALTITUDE LEVEL RELEASE AND LEVEL CONSTANT SPEED ESCAPE MANEUVER**

REL KTAS	SAFE ARMING TIME SEC	VERTICAL DROP TO FUZE ARMING FT	AIRCRAFT TO BOMB SLANT RANGE DISTANCE AT FUZE ARMING FT
GP BOMBS			
260	6.1	600	1451
320	5.6	500	1332
380	5.0	400	1123
MK 81, MK 82			
260	5.0	400	1015
320	5.0	400	1080
380	5.0	400	1123

NOTE

The values listed are applicable for use with singles, pairs, or salvo type releases and assume that the aircraft attains the 4.0 g escape maneuver acceleration within two seconds after release.

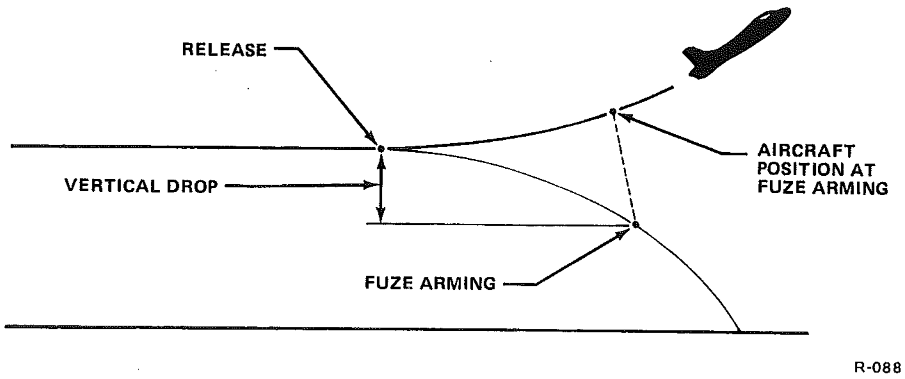


Figure 6-20. (Sheet 2)

FUZE ARMING DISTANCE

- **LOW ALTITUDE LEVEL RELEASE 4.0 g PULL UP TO 20° - 30° CLIMB ESCAPE MANEUVER**

RELEASE		SAFE ARMING TIME SEC	VERTICAL DROP TO FUZE ARMING FT	AIRCRAFT TO BOMB SLANT RANGE DISTANCE AT FUZE ARMING FT
TAS	DIVE ANGLE DEGREES			
GP BOMBS				
260	10	5.5	900	1327
	20	5.2	1200	1233
	30	5.1	1500	1159
320	15	5.1	1100	1177
	30	4.9	1700	1104
	50	4.8	2300	986
380	20	4.8	1400	1048
	30	4.8	1900	1061
	50	4.7	2600	943
MK 81, MK 82				
260	10	5.1	800	1144
	20	4.9	1100	1075
	30	4.5	1300	893
320	15	4.7	1000	1005
	30	4.5	1500	872
	50	4.4	2100	819
380	20	4.5	1300	913
	30	4.4	1700	852
	50	4.3	2400	795

NOTE

The values listed are applicable for use with singles, pairs or salvo type releases and assume that the aircraft attains 4.0 g escape maneuver acceleration within two seconds after release,

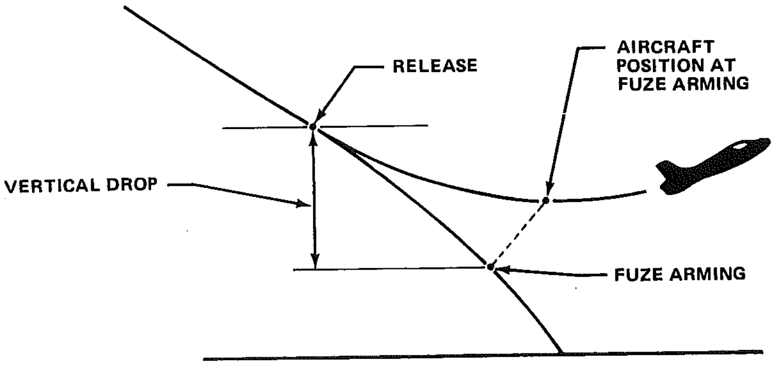


Figure 6-20. (Sheet 3)

AERIAL ATTACK SIGHT CORRECTION

It is suggested to apply the following corrections to lead angle & gravity drop to computed sight settings for "non standard" pursuit curve.

A. FIXED SIGHTS ([B] aircraft)

- Correct lead angle by ± 3 mils for ± 10 kt target speed change
- Correct lead angle by ± 1 mils for ± 100 ft slant range change
- Correct lead angle by ± 2 mils for ± 10 kt fighter speed change
- Correct lead angle by ± 3 mils for ± 1 degr. angle off change
- Correct gravity drop by ± 0.15 mils for ± 100 ft slant range change

B. GYRO SIGHTS ([A], [C], [D] aircraft)

- No correction for target speed change
- No correction for angle off change
- Correct lead angle by ± 1 mil for ± 100 ft slant range change
- Correct lead angle by ± 1 mil for ± 10 kt fighter speed change
- Correct gravity drop by ± 0.15 mils for ± 100 ft slant range change

BOMB BALLISTIC DATA

For some types of bombs the bombing tables have not been calculated by digital values. A series of graphs (Volume 2) have instead been drawn to find sight depression angle. For the purpose of these graph, bombs are divided into three Classes (A, B and C) dependent on ballistic coefficient. Specific types of bombs are listed beneath their respective classes in the next paragraph. Angles of depression, MEASURED FROM FLIGHT PATH, are given for each class. To obtain the proper sight angle for a particular type of pass, the following calculations must be made by the pilot:

1. Determine the class of the bomb and the intended dive angle and select the proper graph.
2. For a given release altitude (above target) or for a given aircraft slant range find, across the release CAS, the depression angle.
3. Find the bomb horizontal range by the fig. 6-4 Section VI, to calculate the slant range.
4. Find the sight setting by adding as follows:

   a. Depression angle (graphs from Volume 2) mils
   b. Zero sight line angle of attack (fig. 6-3) ± mils
   c. Rangewind correction + mils
   d. Parallax correction (fig. 6-11) + mils
   e. Windshield refraction correction (fig. 6-14) + mils
   Sight setting (a + b + c + d + e) = mils

Rangewind and crosswind component must be calculated from figure 6-8, then the wind correction factors will be found from the bombing tables from Volume 2 assuming the correction factors are the same for the same dive angle, release airspeed and slant range of ANY BOMB HAVING SIMILAR BALLISTIC INDEX NUMBER.

DEPRESSION ANGLE INTERPOLATION

If necessary, interpolate as follows:

(1) - For release altitude interpolation: Determine the depression angle (mils) for the altitude (H_p) represented on the graph nearest to the required altitude (H_R), then resolve the following proportion:

$$\frac{H_P}{D_P} = \frac{H_R}{X}$$

H_P = Altitude plotted in the table

H_R = Altitude required.

D_P = Sight depression plotted.

X = Sight depression for the required altitude.

(2) - For dive angle interpolation: Find the depression angle (as explained above) for the two plotted dive angles between which the required dive angle is included, then make the proportion like the example.

Depression angle for 40° . . . . . 119 mils

Depression angle for 50° Dive . . 96 mils

Depression angle for the required 45° dive, by interpolation is 107.5 mils.

BOMB CLASSIFICATION

The bomb types are divided into three classes (A, B and C) dependent on ballistic index number.

NOTE

BALLISTIC PERFORMANCE INDEX NUMBER (finned bomb only) obtained as follows:

$$I_b = \frac{W}{R_b} \text{ (ballistic index)}$$

$$R_b = \frac{\pi D^2}{4} + 0.44 \text{ DL}$$

R_b = Ballistic drag index

W = Mass in lb

D = Diameter of the bomb in inches

L = Total length of the bomb in inches

$\frac{\pi D^2}{4}$ = Cross section of the bomb

CLASS "A" BOMBS

Ballistic performance index number greater than 0.65 (assumed to be 0.95).

500 lb and 1000 lb SAP

500 lb GP old series (AN-M64A1; SAMP type 25)

500 lb AP old series

250 lb GP conical fin bombs

220 lb and 260 lb fragmentation bombs (AN-M81; MATRA 81)

100 lb practice bombs (M38A2)

500 lb practice bombs, wetsand filled (MK 86)

25 lb practice bombs (MK 76)

NOTE

Wind correction factors for Class A bombs are the same as for AN-M64A1 GP bomb.

CLASS "B" BOMBS

Ballistic performance index numbers between 0.65 or 0.35 (assumed to be 0.5).

100 lb and 250 lb GP old series (AN-M30A1, SAMP Type 57, MATRA Type 50 kg, NA-M571A box type fin).

Round nose depth bombs

100 lb chemical bombs

500 lb practice bombs water filled (MK86)

100 lb practice bombs - M15 mod. 2 wetsand filled.

100 lb practice bombs - AN-M38A2 wetsand filled.

4.75 lb practice bomb (AN-MK43).

NOTE

Wind correction factors for Class B bombs are the same as for BDU-33A/B practice bomb.

CLASS "C" BOMBS

Ballistic performance index number between 0.35 and 0.18 (assumed to be 0.25).

100 lb incendiary bombs.

100 lb practice bombs, water filled.

Flat nose depth bombs.

3 lb practice bombs. (MK 23 mod. 1; MK 5 mod 2 and 3).

NOTE

Wind correction factors for Class C bombs are the same as for BLU-23B fire bomb.

HOW TO FIND HORIZONTAL RANGE

Horizontal range is already computed on graphs (See Volume 2) relative to Class A, B and C bomb or more precisely, can be found in fig. 6-4.

HOW TO FIND SLANT RANGE

If necessary it is easy to find the slant range by the formula:

$SR = \sqrt{HR^2 + RA^2}$

HR = horizontal range nd RA = release altitude

GLOSSARY

A/A: Air-to-Air.

ADL: Armament Datum Line. The base or zero line for all sight computations prior to parallax correction (zero sight line).

ADVERSE YAW: A yaw opposite to the direction of turn, induced by rolling motion and aileron deflection. The yaw moment greatest at high lift conditions and full aileron deflections.

A/G: Air-to-Ground.

AGL: Altitude Above Ground Level.

AIMPOINT: The preplanned point near or on the target that is used to align the pipper. Usually this is a point that is offset from the target to correct for the wind effect.

AIRCRAFT AXES: There are three axes which are mutually perpendicular and have a common point of intersection:

a. Longitudinal Axis: This axis is parallel to the fuselage reference line. Rotating the longitudinal axis will change the aircraft angle of attack and/or pitch.

b. Vertical Axis: This Axis is perpendicular to the longitudinal axis. The aircraft rotates about this axix when yawing.

c. Lateral Axis: This axis rotates about the longitudinal axis when the aircraft is rolled or banked.

ANGLE OF ATTACK: The angle between the fuselage reference line and the relative wind.

ANGLE-OFF: The angular measurement between line of flight of an aerial target and flight path of the attacking aircraft.

ANGLE OF GUNFIRE (AGF): The angle between the fixed bore line and flight path.

ANGLE OF INCIDENCE: A fixed angle between the wing chord line and the fuselage reference line.

ANGLE OF PITCH: The angle of the aircraft flight path relative to a level plane.

BDU: Bomb Dummy Unit.

BLU: Bomb Live Unit.

BORESIGHTING: Harmonization.

BOMB TRAJECTORY: The path of a bomb from release to detonation. The trajectory is the result of bomb ballistics, release velocity, release angle, and release height above burst.

BULLET DENSITY: Number of rounds passing through an area of 1 square foot for unit of time.

BULLET DISPERSION: Deviation of a bullet trajectory from the aiming point.

CBU: Cluster Bomb Unit.

CORRECTED SIGHT DEPRESSION: True sight depression corrected for a head or tailwind component.

EFFECTIVE BORE LINE (EBL): Bullet of departure, disregarding gravity drop.

EFFECTIVE SIGHT DEPRESSION: The amount of depression represented by the angle formed by the flight path and the depressed sight line. This angle varies as flight conditions vary; however, the angle formed by the true zero prediction sight line and the depressed sight line will remain a constant. Effective and required sight depression will be the same when preplanned flight conditions are met.

F-FACTOR: F-Factor is a mathematical value applied in rocket fire computation to compensate for the rocket's deviation from launcher line toward flight path.

FFAR: Folding Fin Aircraft Rocket.

FIRE BOMB: Napalm, Anti-Pam (Personnel and Material), an incendiary munition.

FIXED BORE LINE (FBL) or FIXED GUN LINE (FGL): An imaginary line projected through the gun barrel to infinity.

FMU: Fuze Munition Unit.

FOUL LINE: A line, metarialized on the ground, beyond which firing (on the figure range) is prohibited and the obtained results are scored null.

FUSELAGE REFERENCE LINE (FRL): A basic reference line extending the fuselage parallel to the longitudinal axis of the aircraft.

FUSELAGE ANGLE OF ATTACK: The angle in mils between the aricraft flight path and the fuselage reference line.

GP BOMB: General Purpose Bomb.

GRAVITY DROP: The distance in the vertical plane an ordnance is deflected from its mean line of departure, due to the force to gravity.

GROUND SPEED: The speed of the aircraft releative to the ground (True airspeed plus or minus the rangewind component).

GROUND TRACK: The path or actual line of movement of the aircraft over the ground.

HARMONIZATION: The adjustement (or boresighting) of the gun barrel so that, when the guns are fired at the most effective range, the pipper will be on the bullet impact point.

HDGP: High Drag General Purpose Bomb.

HE: High Explosive.

HEI: High Explosive Incendiary.

HEAT: High Explosive Anti-Tank.

HEAP: High Explosive Anti-Personnel.

HVAR: High Velocity Aircraft Rocket.

KCAS: Knots Calibrated Airspeed.

KTAS: Knots True Airspeed. Calibrated airspeed corrected for temperature and pressure.

LAU: Launcher Unit.

LAUNCHER LINE (LL): The line along which a rocket is fired from the aircraft.

LINEAR ACCELERATION: A change in velocity or rate for such change measured in a straight line.

LINE OF DEPARTURE (LOD): The path that a rocket takes immediately after leaving the aircraft. The LOD is always located in the angle formed by the launcher line and the flight path. The rocket's line of departure is a resultant of the firing velocity of the rocket along the launcher line and the aircraft speed along the flight path.

MEAN FIXED BORE LINE (MFBL): An average of all bore lines.

MIL: A miliradian which is 1/1000 of a radian (17.45 mils = 1 degree).

MSL: Mean Seal Level.

NM: Nautical Mile (6076.1 feet = 1853 m).

PARALLAX ERROR: Displacement or separation between the optical sight reticle and the point at which the specific armament is suspended.

PERCH: Referred to air-to-air practice gunnery. Position higher and lateral respect to the aerial target from which the gunfire pass is started.

PICKLE: The bomb release button, or the action of depressing the bomb release button.

PREDICTION ANGLE: Total lead angle required after calculations for target motion, trajectory motion, trajectory shift, gravity drop, and air density.

PRESSURE ALTITUDE: The altitude read on the pressure altimeter when set on 1013.25 millibars (29.92 inches Hg).

RADIAL-G. The centrifugal force required to track a target.

REQUIRED SIGHT DEPRESSION: The amount of depression below the flight path necessary to produce an effective sight picture, determined by flight conditions of dive angle, airspeed, and release altitude.

RESULTANT FORCE: A single force whose direction and magnitude result from several combined forces.

SIGHT DEPRESSION FROM FLIGHT PATH: The optical depression below the flight path ncessary.

SIGHT LINE (SL): A sight line which has been depressed to correct for parallax and becomes the base or zero line for all sight computations.

SIGHT PICTURE: The relationship of the sight reticle to the target, as it appears to the pilot.

SIGHT SETTING: The value in mils that the optical sight is depressed.

SLANT RANGE (SR): The distance from the aircraft to the target at the time of firing guns, missiles, rockets or releasing bombs.

SUU: Suspension and Release Unit.

TANGENTIAL THROW: The deflection of the projectiles from the fixed gun bore line due to rotational velocity of the gun barrels (minigun).

TARGET ELEVATION: The height of the target of IP above mean sea level (MSL).

THEORETICAL FIXED MEAN BORE LINE: Effective gun bore sight line (EGBSL). Theoretical line through the index barrel of the gun which compensates for the tangential throw of the gun.

TOTAL G: Radial-G plus or minus component of 1-G gravity.

TRACKING INDEX: The aiming point, pipper, cross, etc., used by the pilot in weapon delivery.

TRACK CROSSING ANGLE: The angle between headings of the interceptor and the target.

TRAJECTORY SHIFT: The angular deviation of the bullet trajectory from the fixed gun barrel toward the flight path of the aircraft. Also applicable to rockets and missiles.

TRUE SIGHT DEPRESSION: A no-wind sight setting computed for preplanned release conditions.

VELOCITY JUMP: The angle through which a projectile rotates, in the verticle plane, as it shifts into the relative airflow.

ZERO SIGHT LINE (ZSL): The base or zero line for all sight computations prior to parallax correction.